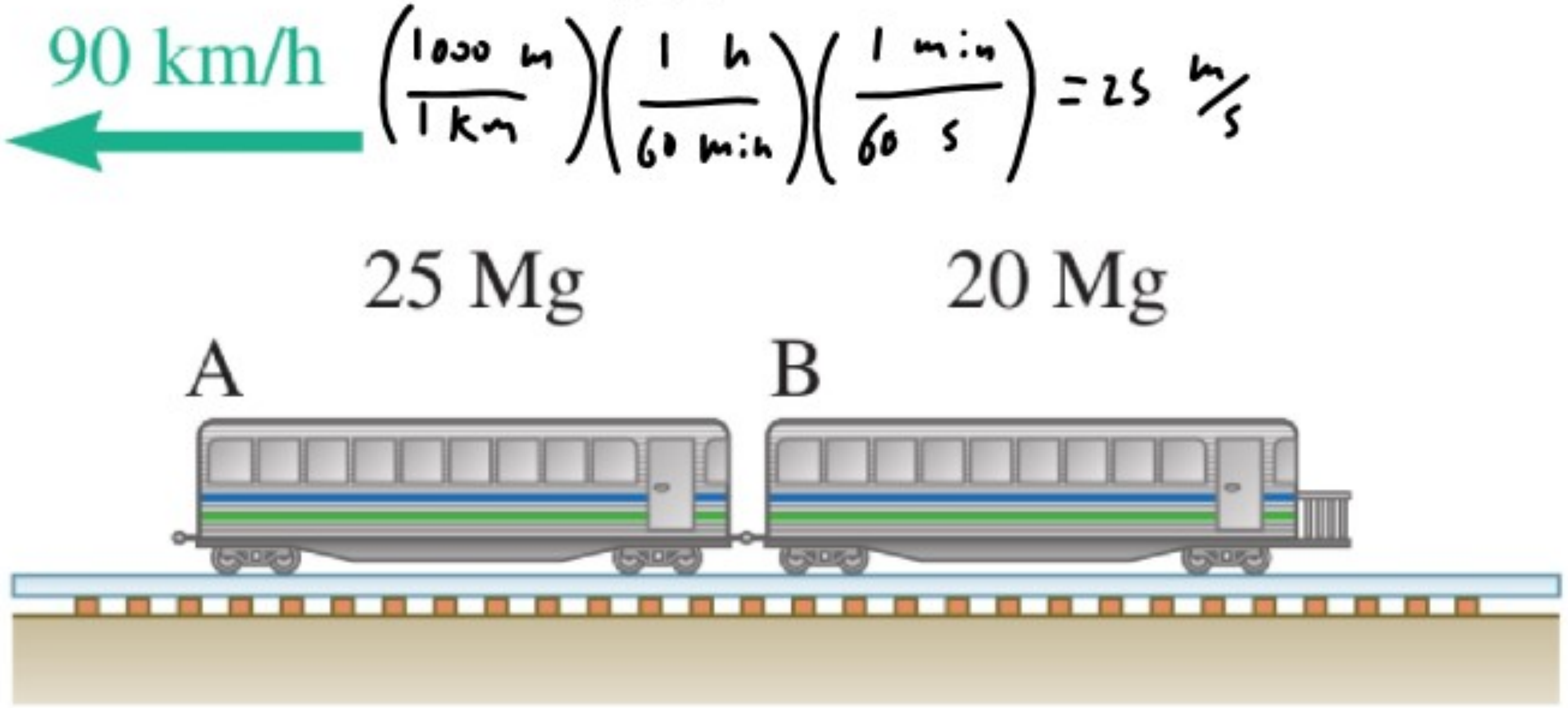
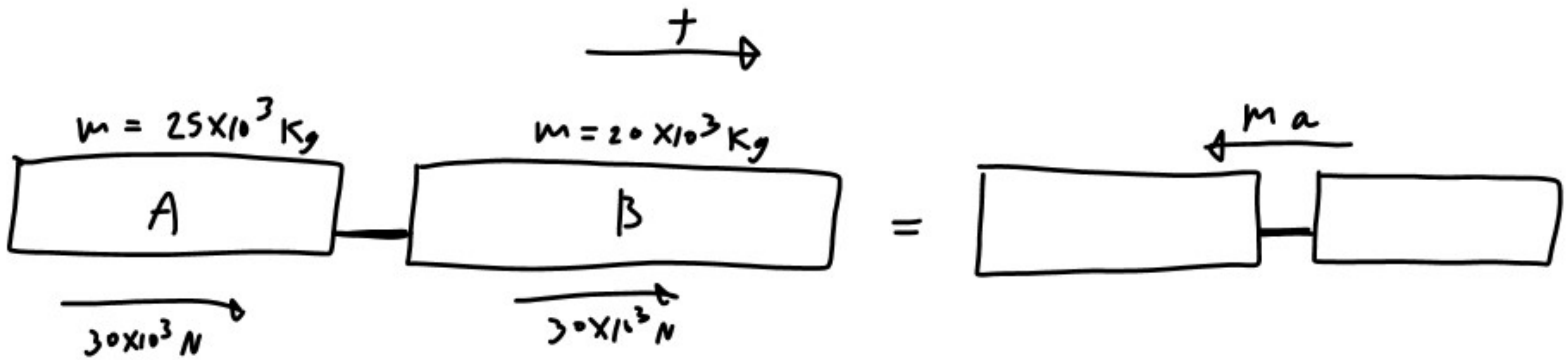
A light train made up of two cars is traveling at 90 km/h when the brakes are applied to both cars. Knowing that car A has a mass of 25 Mg and car B a mass of 20 Mg, and that the braking force is 30 kN on each car, determine (a) the distance traveled by the train before it comes to a stop, (b) the force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

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

$1 \text{ Mg} = 1000 \text{ kg}$

$\left(\frac{1000 \text{ m}}{1 \text{ km}}\right)\left(\frac{1 \text{ h}}{60 \text{ min}}\right)\left(\frac{1 \text{ min}}{60 \text{ s}}\right) = 25 \text{ m/s}$





$$\Sigma F = ma$$

$$30\times10^3 + 30\times10^3 = -(25\times10^3 + 20\times10^3)\,a$$

$$\frac{-30\times10^3 + 30\times10^3}{25\times10^3 + 20\times10^3} = -1.333 \ \mathrm{m/s^2}$$

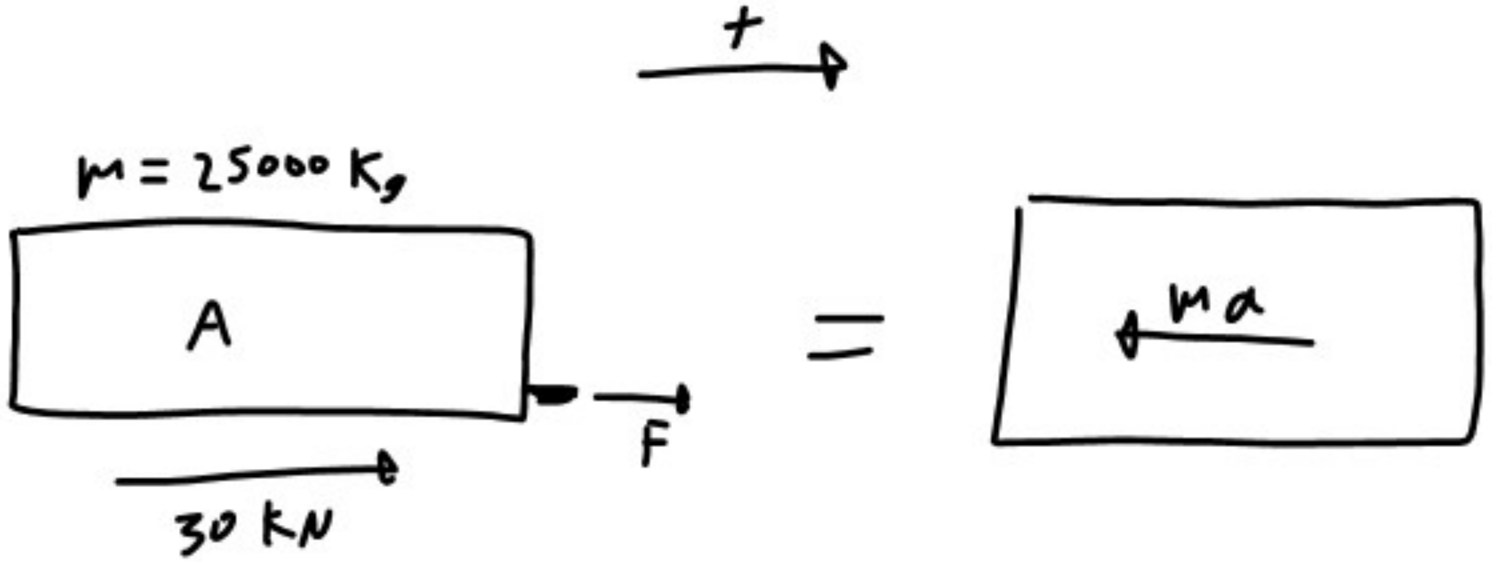
$$X = X_0 + V_0 t + \frac{1}{2} a t^2$$

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

$$0^2 = 25^2 + 2(-1.333)(x - 0)$$

$$25^2 = 2(1.333)\,x$$

$$\frac{25^2}{2(1.333)} = \boxed{234 \ \mathrm{m}}$$



$$\Sigma F = ma$$

$$30\times10^3 + F = -25\times10^3(-1.333)$$

$$-30\times10^3 + 25\times10^3(1333) = F$$

$$F = 3333N$$

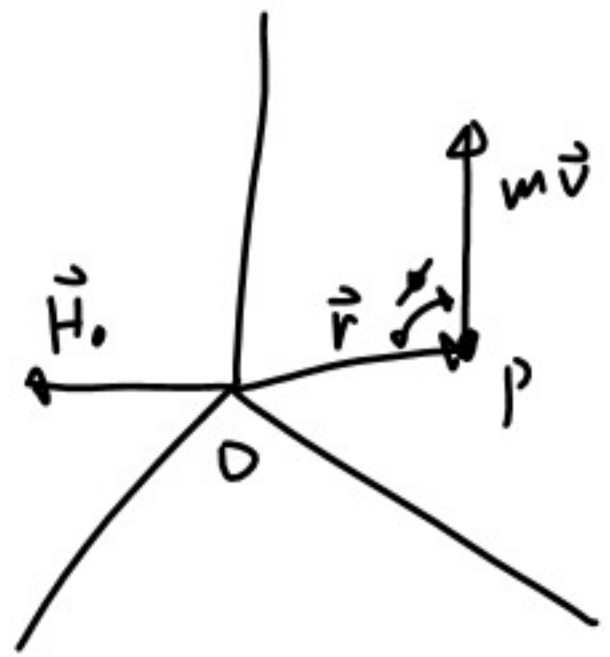
Angular Momentum

$\vec{H}_0 = \vec{r} \times m\vec{v}$

$H_0 = rmv\sin\phi$

$H_0 = mr^2\dot{\theta}$

H_0 constant (conservation of energy)



A space vehicle is in a circular orbit with a 1400-mi radius around the moon. To transfer to a smaller orbit with a 1300-mi radius, the vehicle is first placed in an elliptic path *AB* by reducing its speed by 86 ft/s as it passes through *A*. Knowing that the mass of the moon is 5.03×10^{21} lb·s^2/ft, determine (*a*) the speed of the vehicle as it approaches *B* on the elliptic path, (*b*) the amount by which its speed should be reduced as it approaches *B* to insert it into the smaller circular orbit.

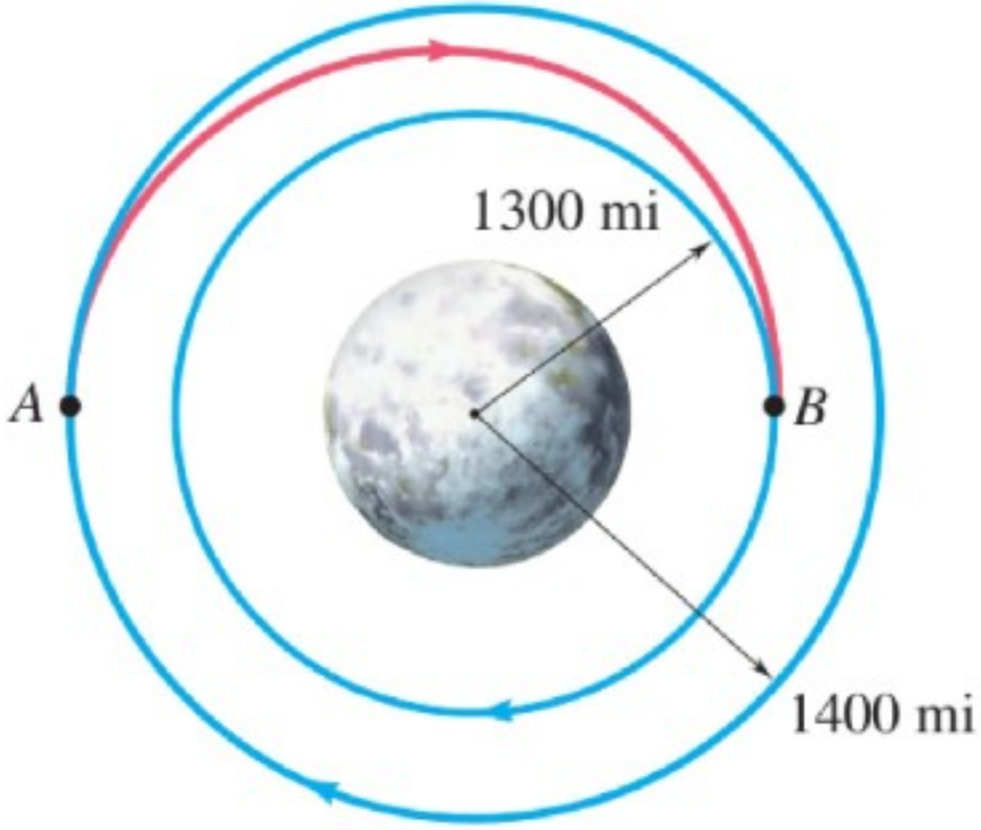
$$\vec{a}_n = \frac{dv}{dt}\vec{e}_t + \frac{v^2}{\rho}\vec{e}_n$$

(ρ — radius)

$$\vec{a}_A = \frac{v^2}{1400\ mi}\vec{e}_n$$

$$\vec{F} = m\vec{a}_n \qquad \frac{\vec{F}}{m} = \frac{v^2}{\rho}\vec{e}_n$$

$$\frac{GMm/r^2}{m} = \frac{v^2}{\rho} \qquad \frac{GM}{r^2} = \frac{v^2}{\rho}$$



$$F = \frac{GMm}{r^2}$$