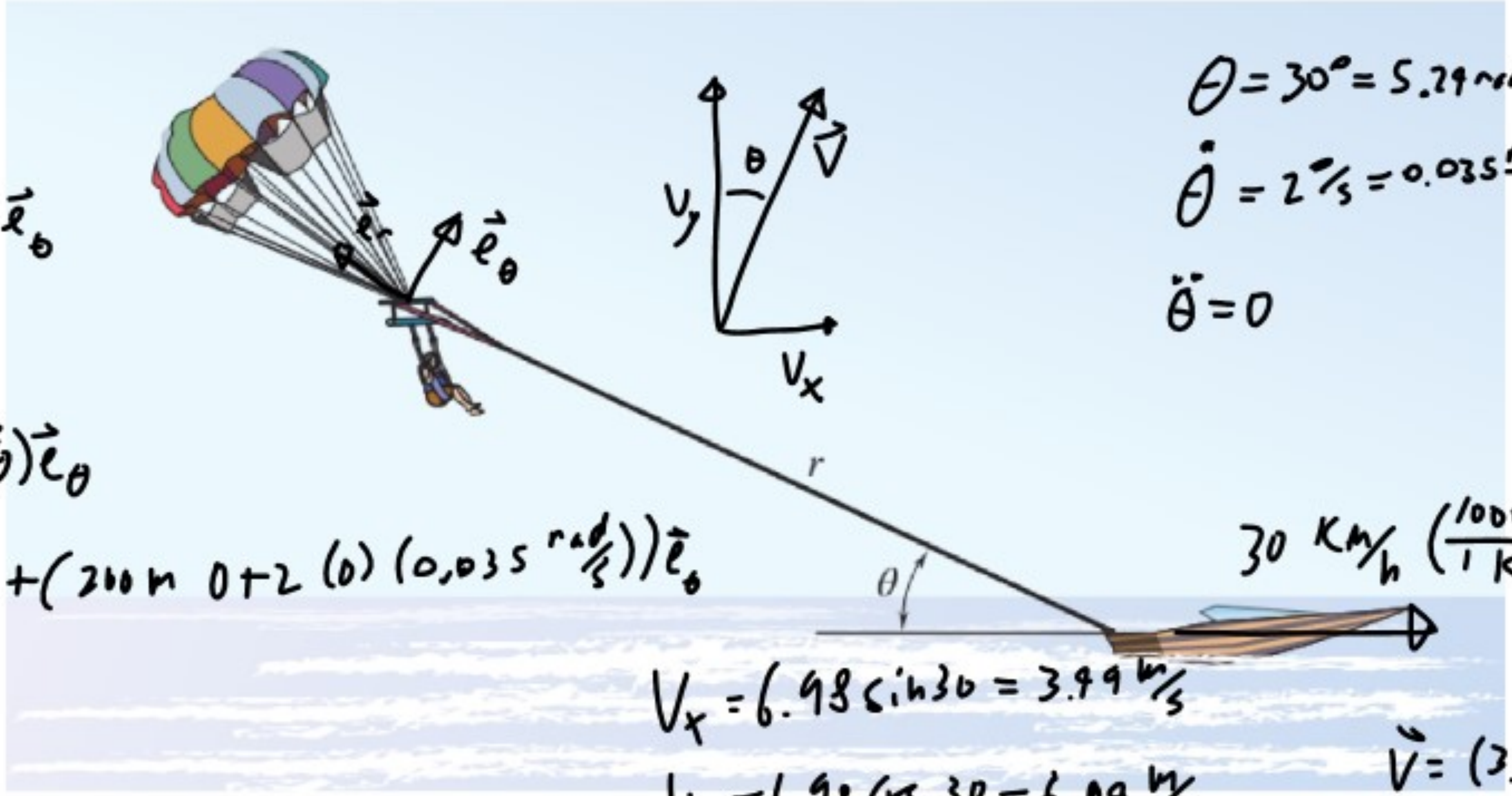
During a parasailing ride, the boat is traveling at a constant 30 km/hr with a 200-m long tow line. At the instant shown, the angle between the line and the water is 30° and is increasing at a constant rate of 2°/s. Determine the velocity and acceleration of the parasailer at this instant.



$\theta = 30° = 5.24\,rad$ $r = 200\,m$

$\dot{\theta} = 2°/s = 0.035\,\frac{rad}{s}$ $\dot{r} = 0$

$\ddot{r} = 0$

$\ddot{\theta} = 0$

$\vec{V} = \dot{r}\vec{e}_r + r\dot{\theta}\vec{e}_\theta$

$= 0\vec{e}_r + 200\,m\ 0.035\,\frac{rad}{s}\vec{e}_\theta$

$= 6.98\ \vec{e}_\theta\ m/s$

$\vec{a} = (\ddot{r} - r\dot{\theta}^2)\vec{e}_r + (r\ddot{\theta} + 2\dot{r}\dot{\theta})\vec{e}_\theta$

$= (0 - 200\,m\,(0.035\,\frac{rad}{s})^2)\vec{e}_r + (200\,m\ 0 + 2\,(0)\,(0.035\,\frac{rad}{s}))\vec{e}_\theta$

$\boxed{= -0.245\,\vec{e}_r\ m/s^2}$

$30\,km/h\left(\frac{1000\,m}{1\,km}\right)\left(\frac{1\,h}{60\,min}\right)\left(\frac{1\,min}{60\,s}\right) = 8.33\,m/s$

$V_x = 6.98\sin 30 = 3.49\,m/s$

$V_y = 6.98\cos 30 = 6.04\,m/s$

$\vec{V} = (3.49 + 8.33)\,i + 6.04\,j\ m/s$

$\boxed{= 11.82\,i + 6.04\,j\ m/s}$

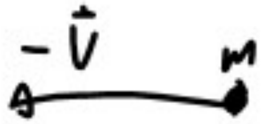
Newton's second Law

$\vec{F} = m\vec{a}$ $\qquad$ $\sum \vec{F} = \vec{0}$

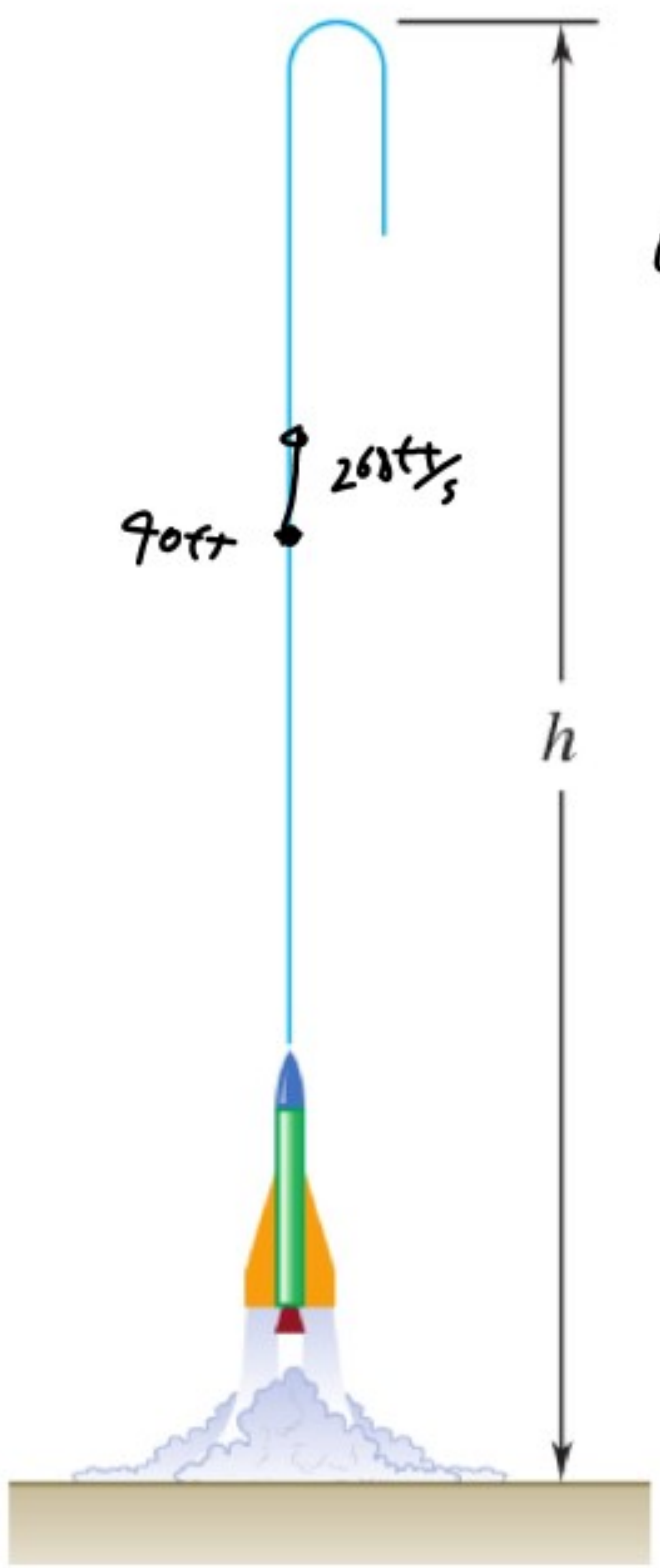
momentum

$\sum \vec{F} = m\vec{a}$ $\qquad$ $\vec{F} = m\dfrac{d\vec{v}}{dt} = \dfrac{d}{dt} m\vec{v}$ $\qquad$ $\vec{L} = m\vec{v}$

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



$\frac{1}{2} m v^2$



$0.5\ oz\left(\frac{1\ lb}{16\ oz}\right) = 0.03125\ lb$ $\quad m = \frac{0.03125\ lb}{32.2\ ft/s^2} = 9.7\times10^{-4}$ slugs

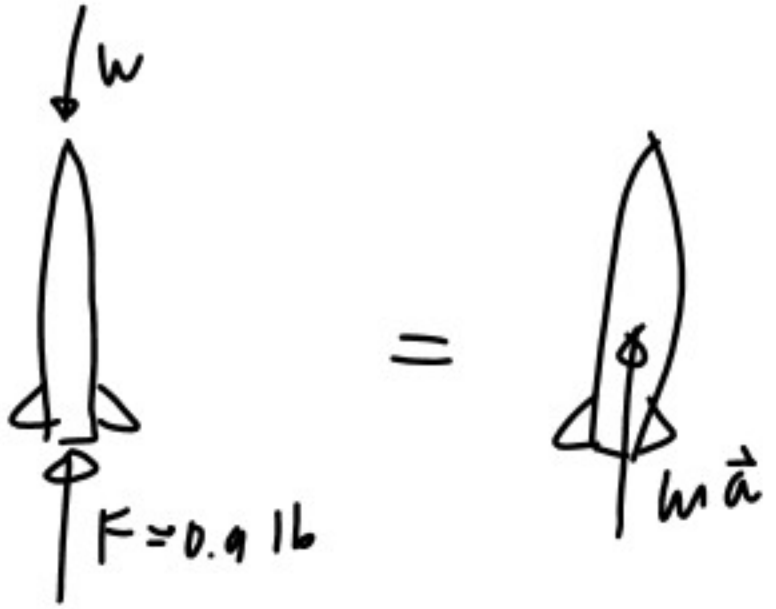
$0.9 - 0.03125 = ma \Rightarrow 0.869 = 9.7\times10^{-4}\, a$

$a = \frac{0.869}{9.7\times10^{-4}} = 896\ ft/s^2$

$V = V_0 + at$

$V(0.3) = 896(0.3) = 268\ ft/s$

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.



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

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

$= 40$ ft

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

$$V = V_0 + at$$

$$0^2 = 268^2 + 2(-32.2)(y - 40)$$

$$263^2 = 2(32.2)(y - 40)$$

$$\frac{263^2}{2(32.2)} = y - 40$$

$$\frac{263^2}{2(32.2)} + 40 = y = \boxed{1161 \text{ ft}}$$