Negligible Mass.

$$PE_{top} + KE_{top} = PE_x + KE_x$$

$$0 + 0 = -Mgx + \frac{1}{2}Mv^2.$$

$$\frac{1}{2}v^2 = gx$$

$$v = \sqrt{2gx}.$$

$$\frac{dv}{dx} = \sqrt{2g} \cdot \frac{1}{2} \cdot x^{-\frac{1}{2}} = \sqrt{g/2x}$$

$$a = \frac{dv}{dx} \cdot \frac{dx}{dt} = \frac{dv}{dx} \cdot v = \sqrt{g/2x} \cdot \sqrt{2gx} = g.$$

Rope Hangs down.

$$PE_{top} + KE_{top} = PE_x + KE_x.$$

$$-\rho\frac{L}{2} \cdot g \cdot \frac{L}{4} - \rho\frac{L}{2} \cdot g \cdot \frac{L}{4} + 0 = -mgx - \rho\left(\frac{L+x}{2}\right) \cdot g \cdot \left(\frac{L+x}{4}\right) - \rho\left(\frac{L-x}{2}\right) \cdot g \cdot \left(\frac{L+3x}{4}\right)$$
$$+ \frac{1}{2}Mv^2 + \frac{1}{2}\rho\left(\frac{L-x}{2}\right)v^2.$$

$$-\rho g\frac{L^2}{4} = -mgx - \frac{\rho g}{8}\left[L^2 + 2xL + x^2 + L^2 + 2xL - 3x^2\right] + \frac{1}{2}Mv^2 + \frac{1}{2}\rho\left(\frac{L-x}{2}\right)v^2.$$

$$-\rho g L^2 = -4Mgx - \frac{1}{2}\rho g(2L^2 + 4xL - 2x^2) + (2m + \rho(L-x))v^2.$$

$$(2M + \rho(L-x))v^2 = 4mgx + \rho g(L^2 + 2xL - x^2) - \rho g L^2.$$

$$(2M + \rho(L-x))v^2 = 4mgx + \rho g x(2L-x)$$

$$v = \sqrt{\frac{4mgx + \rho g x(2L-x)}{2m + \rho(L-x)}}$$

$$\frac{dv}{dx} = \frac{g(\rho^2x^2 - (2L\rho^2 + 4M\rho)x + 2\rho^2L^2 + 8LM\rho + 8M^2)}{2(\rho(x-L) - 2M)^2\sqrt{\frac{4mgx + \rho g x(2L-x)}{2M + \rho(L-x)}}}$$

$$a = \frac{dv}{dx} \cdot v = \frac{g(\rho^2x^2 - 2L\rho^2x - 4M\rho x + 2L^2\rho^2 + 8ML\rho + 8M^2)}{2(\rho(x-L) - 2m)^2}.$$

Rope Starts at top.

$$PE_{top} + KE_{top} = PE_x + KE_x.$$
$$0 + 0 = -mgx - \rho x \cdot g \cdot \frac{x}{2} + \frac{1}{2}mv^2 + \frac{1}{2}\rho x \left(\frac{v}{2}\right)^2.$$

$$(m + \tfrac{1}{4}\rho x)v^2 = 2mgx + \rho g x^2$$
$$(4M + \rho x)v^2 = 4gx(2M + \rho x)$$

$$v = \sqrt{\frac{4gx(2M+\rho x)}{(4M+\rho x)}}$$

$$\frac{dv}{dx} = \frac{2g(\rho^2 x^2 + 8M\rho x + 8M^2)}{(\rho x + 4M)^2 \sqrt{\frac{4gx(2M+\rho x)}{4M+\rho x}}}$$

$$a = \frac{dv}{dx} \cdot v = \frac{2g(\rho^2 x^2 + 8M\rho x + 8M^2)}{(\rho x + 4M)^2}.$$