1) $\sum \vec{F} - \cancel{\iiint_V \rho \vec{a}\, dV} = \cancel{\frac{d}{dt}\iiint_V \rho \vec{v}\, dV} + \iint_S \rho \vec{v}\,\vec{v}\cdot\hat{n}\, dS$

$$\sum F = \iint_S \rho v_x \vec{v}\cdot\hat{n}\, dS$$

$$-\mu M g = \rho (v_j - v)\left[-(v_j - u)\right] S$$

$$(v_j - u) = \sqrt{\frac{\mu M g}{\rho S}}$$

$$= \sqrt{\frac{0.5\ (75 kg)(9.81 m/s^2)}{(1000 kg/m^3)(0.005 m^2)}}$$

$$= 8.58 \text{ m/s}$$

$$u = v_j - 8.58 \text{ m/s}$$

$$\boxed{= 21.42 \text{ m/s}}$$

2)

$$\sum \vec{F} - \iiint_V \rho \vec{a}\, dV = \frac{d}{dt}\iiint_V \rho \vec{v}\, dV + \oint_S \rho \vec{v}\,(\vec{v}\cdot\hat{n})\, dS$$

$$-Ma_x = -\rho(V_j - v)^2 S - \rho(V_j - v)^2 \cos\theta\, S$$

$$-M\frac{dv}{dt} = -\frac{3}{2}\rho(V_j - v)^2 S$$

$$\frac{dv}{dt} = \frac{3\rho S}{2M}(V_j - v)^2$$

$$\int_0^v \frac{dv}{(V_j - v)^2} = \int_0^t \frac{3\rho S}{2M}\, dt$$

$$\frac{1}{V_j - v}\Big]_0^v = \frac{3\rho S}{2M} t$$

$$\frac{1}{v_j - u} - \frac{1}{v_j} = \frac{3}{2}\frac{g s}{M} +$$

$$u = v_j \left[+ \frac{}{+ + \frac{2M}{3 s g v_j}} \right]$$

$$u = 20\ m/s \left[+ \frac{}{+ + \left(\frac{1}{3}\right) s} \right]$$

3) $\sum F_x - \iiint_V \rho a_x \, dV = \frac{d}{dt} \cancel{\iiint_V \rho u_x \, dV}^{\to 0} + \iint_S \rho u_x \vec{v} \cdot \vec{n} \, dS$

$$-Mg\mu - Ma_x = \rho (v_j - u)[-(v_j - u)] S$$

$$Mg\mu + M\frac{du}{dt} = \rho (v_j - u)^2 S$$

$$\frac{du}{dt} = \mu g \left[\frac{\rho S}{M\mu g} (v_j - u)^2 - 1 \right]$$

$$\frac{du}{dt} = -\mu g \left[1 - \frac{\rho S}{M\mu g} (v_j - u)^2 \right]$$

$$\frac{du}{1 - \frac{\rho S}{M\mu g} (v_j - u)^2} = -\mu g \, dt$$

define $A = \sqrt{\frac{\rho S}{M\mu g}} (v_j - u)$

$$dA = -\sqrt{\frac{\rho S}{M\mu g}} \, du$$

$$\int_{A_0}^{A_1} \frac{dA}{1-A^2} = \int_0^{+} \sqrt{\frac{3S\mu g}{M}}\, dt$$

$$\operatorname{arctanh}(A_1) - \operatorname{arctanh}(A_0) = \sqrt{\frac{3S\mu g}{M}}\, t$$

$$@\ t=0 \quad u=0 \ \text{\&}\ A = \sqrt{\frac{3S}{M\mu g}}\, V_j$$

$$\operatorname{arctanh}(A_1) = \sqrt{\frac{3S\mu g}{M}}\, t + \operatorname{arctanh}\left(\sqrt{\frac{3S}{M\mu g}}\, V_j\right)$$

$$A_1 = \tanh\left[\sqrt{\frac{3S\mu g}{M}}\, t + \operatorname{arctanh}\left(\sqrt{\frac{3S}{M\mu g}}\, V_j\right)\right]$$

$$\sqrt{\frac{3S}{M\mu g}}\,(V_j - u) = \tanh\left[\sqrt{\frac{3S\mu g}{M}}\, t + \operatorname{arctanh}\left(\sqrt{\frac{3S}{M\mu g}}\, V_j\right)\right]$$

$$u = V_j - \sqrt{\frac{M\mu g}{\rho S}} \left\{ \tanh\left[\sqrt{\frac{\rho S \mu g}{M}}\, t + \operatorname{arctanh}\left(\sqrt{\frac{\rho S}{M\mu g}}\, V_j \right) \right] \right\}$$

simple