1)

$a = \beta t^2$, $x_0 = 0$, $v_0 = 0$

$V = 180$ mph, $d = 300$ ft

$\beta = ?$

$\longrightarrow V$ mph $\longrightarrow$ ft/s

$$180 \text{ mph} = \frac{180 \times 5280}{3600} \text{ ft/s}$$

$$= 264 \text{ ft/s}$$

$$a = \beta t^2, \Rightarrow \frac{dV}{dt} = \beta t^2$$

$$\int_0^V dV = \int_0^t \beta t^2 \, dt$$

$$V = \frac{\beta t^3}{3} = 264 \quad -(1)$$

$$V = \frac{\beta t^3}{3} + C$$

$$V = \frac{\beta t^3}{3}, \Rightarrow \frac{ds}{dt} = \frac{\beta t^3}{3}$$

$$\int_0^s ds = \int_0^t \frac{\beta t^3}{3} dt$$

$$\Rightarrow s = \frac{\beta t^4}{12} = 300$$

$\frac{\beta t^3}{3} = 264$ — (a) t & $\beta = ?$

$\frac{\beta t^4}{12} = 300$ — (b)

(b)/(a) $\Rightarrow \frac{\frac{\beta t^4}{12}}{\frac{\beta t^3}{3}} = \frac{t}{4} = \frac{300}{264}$

$\Rightarrow t = \frac{4 \times 300}{264}$

$t = 4.545\,s$

$a = \beta t^2$

$\frac{ft}{s^2} = u(\beta) s^2$

$u(\beta) = \frac{ft}{s^4}$

$\Rightarrow \frac{\beta t^3}{3} = 264$

$\frac{\beta (4.545)^3}{3} = 264$

$\therefore \beta = \frac{3 \times 264}{4.545^3} = 8.433$

$\therefore \beta = 8.433 \frac{ft}{s^4}$

$a \begin{cases} dV/dt \; \times \\ d^2s/dt^2 \; \times \\ V\,dV/ds \; \checkmark \end{cases}$

$a = -g\mu_0\left(1+\frac{s}{\lambda}\right)$ at 0, V_0, $s_0=0$

at f. 0, s.d

$\lambda = f(V_0, d, g, \mu_0)$

$$\frac{V\,dV}{ds} = -g\mu_0\left(1+\frac{s}{\lambda}\right)$$ //

$$\frac{v\,dv}{ds} = -g\mu_0\left(1+\frac{s}{\lambda}\right)$$

$$\int_{v_0}^{0} v\,dv = -\int_0^d g\mu_0\left(1+\frac{s}{\lambda}\right)ds$$

$$\frac{\cancel{v^2}^{\,0} - v_0^2}{2} = -g\mu_0\left(s+\frac{s^2}{2\lambda}\right)\Big|_0^d$$

$$= -g\mu_0\left(d+\frac{d^2}{2\lambda}\right)$$

$$+\frac{V_0^2}{2} = +g\mu_0\left(d + \frac{d^2}{2\lambda}\right)$$

$$V_0^2 = 2g\mu_0 d + g\frac{d^2}{\lambda}\mu_0$$

$$V_0^2 - 2g\mu_0 d = g\frac{d^2}{\lambda}\mu_0$$

$$\Rightarrow \boxed{\lambda = \frac{\mu_0 g d^2}{V_0^2 - 2g\mu_0 d}}$$