Q-1:

$$a = \frac{dv}{dt} = \frac{dv}{ds}\frac{ds}{dt} = v\frac{dv}{ds}$$

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

$$\Longrightarrow vdv = -g\mu_0\left(1 + \frac{s}{\lambda}\right)ds$$

$$\Longrightarrow \int_{v_0}^{0} vdv = \int_{0}^{d} -g\mu_0\left(1 + \frac{s}{\lambda}\right)ds$$

$$\Longrightarrow -\frac{1}{2}v_0^2 = -g\mu_0 d - \frac{g\mu_0 d^2}{2\lambda}$$

$$\Longrightarrow \lambda = \frac{g\mu_0 d^2}{v_0^2 - 2g\mu_0 d}$$

Q-2:

$$a = \frac{dv}{dt} = \frac{dv}{ds}\frac{ds}{dt} = v\frac{dv}{ds}$$

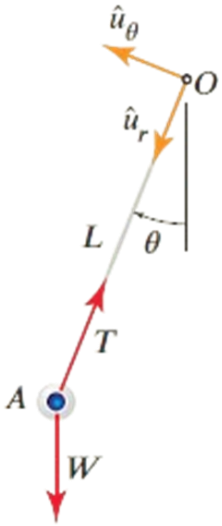
$$\Longrightarrow v\,\frac{dv}{ds} = a_0 - kv^2$$

$$\Longrightarrow \int_{0}^{v_{min}} \frac{v}{a_0 - kv^2}dv = \int_{0}^{d} ds$$

$$\Longrightarrow s = -\frac{1}{2k}\ln\left[\frac{a_0 - kv_{min}^2}{a_0}\right]$$

$$\Longrightarrow s = 1267.81m$$

Q-3:



$$\sum F_\theta = ma_\theta$$

$$\Longrightarrow -W\sin\theta = m\left(r\ddot{\theta} + 2\dot{r}\dot{\theta}\right) = mL\ddot{\theta}$$

$$\Longrightarrow \ddot{\theta} = -\frac{g}{L}\sin\theta$$

$$\Longrightarrow \dot{\theta}\frac{d\dot{\theta}}{d\theta} = -\frac{g}{L}\sin\theta$$

$$\Longrightarrow \int_0^{\dot{\theta}} \dot{\theta}d\dot{\theta} = \int_{\theta_0}^{\theta} -\frac{g}{L}\sin\theta\, d\theta$$

$$\Longrightarrow \dot{\theta}^2 = 2\frac{g}{L}(\cos\theta - \cos\theta_0)$$

$$\sum F_r = ma_r$$

$$\Longrightarrow W\cos\theta - T = m\left(\ddot{r} - r\dot{\theta}^2\right) = -mL\dot{\theta}^2$$

$$\Longrightarrow T = m\left(g\cos\theta + L\dot{\theta}^2\right)$$

$$\Longrightarrow T(\theta = 0^o) = mg(3 - 2\cos\theta_0)$$