$\boxed{14.2}$ $F = \frac{F_o}{b^3}(xy^2\hat{i} + x^2y\hat{j})$ along $y = x$

$y = \frac{x^2}{b}$

$$U = \frac{F_o}{b^3}\left[\int_0^b F_x\, dx + \int_0^b F_y\, dy\right]$$

$y = x$

$$= \frac{F_o}{b^3}\left[\int_0^b x^3\, dx + \int_0^b y^3\, dy\right]$$

$$= \frac{F_o}{b^3}\left(\frac{b^4}{4} + \frac{b^4}{4}\right) = \boxed{\frac{F_o b}{2}}$$

$y = \frac{x^2}{b}$

$x = (yb)^{1/2}$

$$U = \frac{F_o}{b^3}\left[\int_0^b \frac{x^5}{b^2}\, dx + \int y^2 b\, dy\right]$$

$$= \frac{F_o}{b^3}\left(\frac{b^6}{6b^2} + \frac{b^4}{3}\right)$$

$$= F_o b\left(\frac{1}{6} + \frac{1}{3}\right) = \frac{F_o b}{2}$$

14.4

$$U_{A-B\ spring} = -\frac{1}{2}k\left(\delta_B^2 - \delta_A^2\right)$$

$$= -\frac{1}{2}k\left(R^2 - .414^2 R^2\right) = -.414kR^2$$

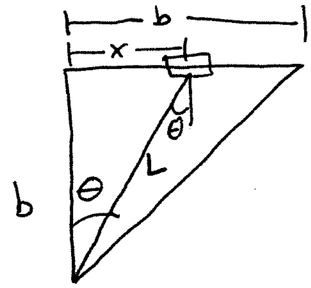
$$\delta_A = \sqrt{R^2+R^2} - R$$

$$= R\sqrt{2} - R = R(\sqrt{2}-1) = .414R$$

$$\delta_B = 2R - R = R$$

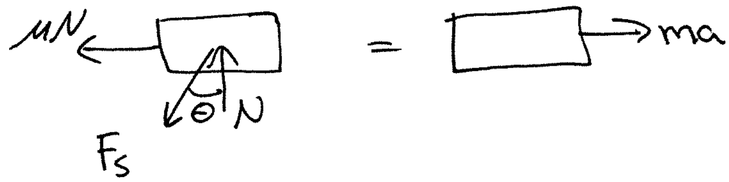
$$U_g = mgh = mgR = U_{grav}$$

$\boxed{14.6}$



$$\cos\theta = \frac{b}{L}$$

$$L = (b^2+x^2)^{1/2}$$



$$\sum F_y = 0 = N - F_s\cos\theta$$

$$N = F_s\cos\theta \qquad F_s = k(L-b)$$
$$\cos\theta = \frac{b}{L}$$

$$N = k(L-b)\left(\frac{b}{L}\right)$$
$$= kb\left(1-\frac{b}{L}\right)$$
$$= kb\left(1 - b(b^2+x^2)^{-1/2}\right)$$

$$U = -\int_0^b \mu N\,dx = -\int_0^b \mu kb\left(1-b(b^2+x^2)^{-1/2}\right)dx$$

$$= -\mu kb\left[x - b\ln\left(x+(b^2+x^2)^{1/2}\right)\right]\Big|_0^b$$

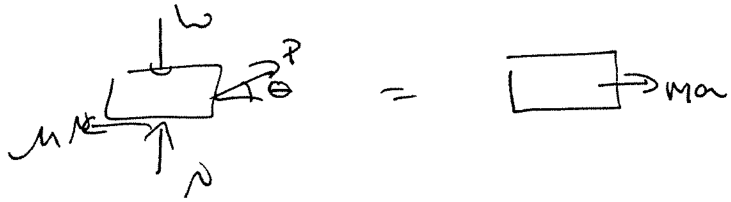
$$= -\mu kb\left[b - b\ln(b+b\sqrt{2}) - 0 + b\ln b\right]$$

$$= -\mu kb\left[b - (b\ln(b+b\sqrt{2}) - b\ln b\right]$$

$$= -\mu kb\left[b - b\ln\left(\frac{b+b\sqrt{2}}{b}\right)\right]$$

$$= -\mu kb^2\left[1-\ln(1+\sqrt{2})\right] = \boxed{-.1186\,\mu kb^2}$$

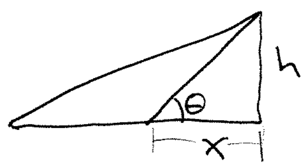
14.8



$$\Sigma F_y = 0 = N - W + P\sin\theta$$

$$N = W - P\sin\theta$$

$$U_{AB} = \int_A^B \mu N\,dx = \mu \int_A^B (W - P\sin\theta)\,dx$$



$$\tan\theta = \frac{h}{x}$$

$$x = \frac{h}{\tan\theta} = h\cot\theta$$

$\theta_1 = 20°$

$\theta_2 = 70°$

$$dx = -h\csc^2\theta\,d\theta$$

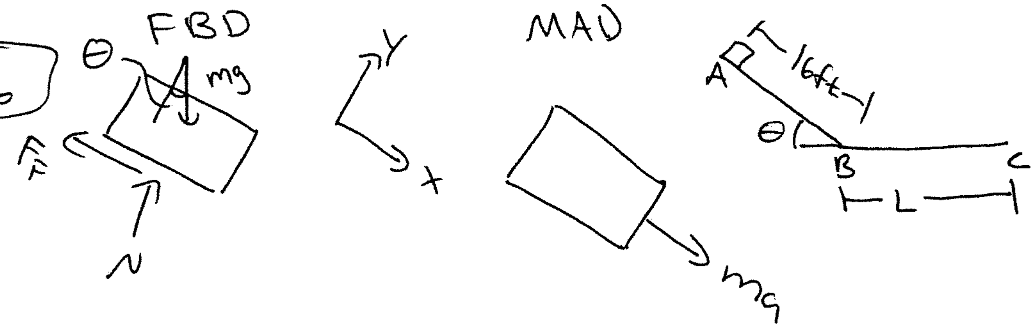
$$U_{AB} = \mu \int_{20}^{70} (W - P\sin\theta)\left(-h\csc^2\theta\,d\theta\right)$$

$$= -\mu h \int_{20}^{70} W\csc^2\theta - P\csc\theta\,d\theta$$

$$= -\mu h \left[-W\cot\theta - P\ln\left(\tan\frac{\theta}{2}\right)\right]_{20}^{70}$$

$$\boxed{U_{AB} = -\mu h(2.38W - 1.38P)}$$

14.16



Down ramp $\theta = 30°$

$F_F = \mu N$

$\Sigma F_y = 0 = N - mg\cos 30 \qquad N = mg\cos 30$

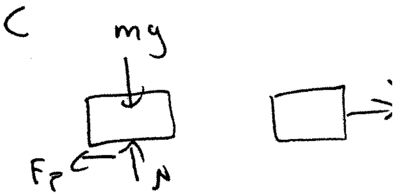
$U_{AB} = -W_{Friction} + W_{Gravity} = T_B - T_A$

$= -mg\cos 30(16) + mg(16\sin 30) = \frac{1}{2}mv_b^2 - 0$

$123.75 \text{ lbft} = \frac{1}{2}v_b^2$

$\boxed{v_b = 15.73 \text{ ft/s}}$

Now sliding across from B to C



$U_{BC} = T_C - T_B = -W_{Friction}$

$-\mu_k N L = 0 - \frac{1}{2}m(v_b)^2$

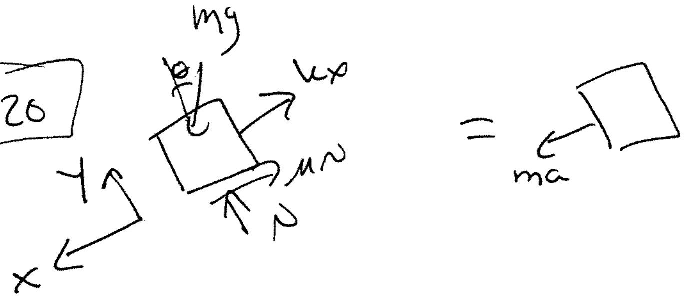
$-\mu_k mg L = -\frac{1}{2}m(v_b)^2$

$\boxed{L = 12.8 \text{ ft}}$

$\Sigma F_y = 0 = N - mg$

$N = mg$

$\boxed{14.20}$



$$N = mg\cos\theta$$

$$F_k = \mu N = \mu mg\cos\theta$$

$$U_{AB} = \Delta T \qquad \left.\begin{array}{l} T_A = 0 \\ T_B = 0 \end{array}\right\} \text{at rest both ends}$$

$$U_{AB} = mg(x\sin\theta) - F_k x - \tfrac{1}{2}kx^2 = 0$$

$$= mgx(\cancel{x}\sin\theta - \mu\cos\theta) - \tfrac{1}{2}kx^2$$

$$x = 0 \quad \text{or} \quad mg(\sin\theta - \mu\cos\theta) - \tfrac{1}{2}kx = 0$$

$$\boxed{x = \frac{2mg(\sin\theta - \mu\cos\theta)}{k}}$$

$$\sin\theta = \frac{\text{drop}}{x}$$

$$\text{drop} = x\sin\theta$$