Pendulum

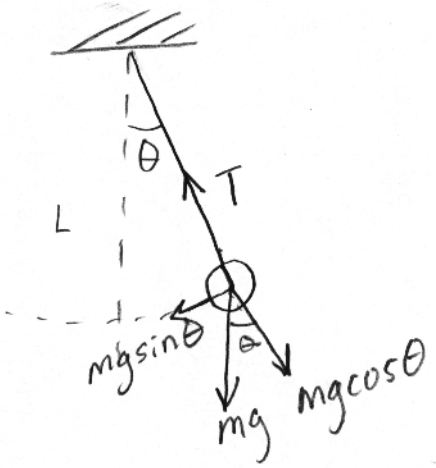
$\theta = 15^\circ = 0.26$ rad

$m = 5$ kg

$g = 10\ m/s^2$

$mg\theta = 13N$ ✓

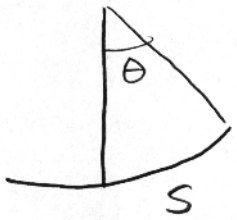
$mg\sin\theta = 12.8N$



$mg\sin\theta$

$\theta = \emptyset \qquad \Sigma F_x = \emptyset$

$$F = -mg\sin\theta$$



$$-mg\sin\theta = ma$$

$$-mg\sin\theta = m\frac{d^2s}{dt^2}$$

$s = R\theta$

$s = L\theta$

$a_t = r\alpha$

$a_t = g\sin\theta$

$g\sin\theta = L\alpha$

$$\alpha = \frac{g\sin\theta}{L}$$

$$\frac{d^2\theta}{dt^2} = -\frac{g}{L}\sin\theta$$

if $\theta < 15^\circ$, $\theta = \sin\theta$

$$\frac{d^2\theta}{dt^2} = -\frac{g}{L}\theta$$

$$\omega = \sqrt{\frac{g}{L}}$$

$$\omega^2 = \frac{k}{m} \approx \frac{g}{L}$$

Energy in Harmonic Motion

$K = \frac{1}{2}mv^2$ $\qquad$ $v = -\omega A \sin(\omega t + \phi)$

$$K = \frac{1}{2} m \omega^2 A^2 \sin^2(\omega t + \phi)$$

$U_s = \frac{1}{2}kx^2$ $\qquad$ $x = A\cos(\omega t + \phi)$

$$U_s = \frac{1}{2} k A^2 \cos^2(\omega t + \phi)$$

$$E = K + U = \frac{1}{2} k A^2 \left[\sin^2(\omega t + \phi) + \cos^2(\omega t + \phi)\right]$$

$$\boxed{E = \frac{1}{2} k A^2}$$