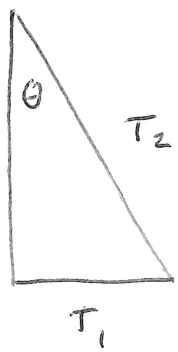
1973 M3

a.



Y-DIMENSION

$F = ma$

$T_2 \cos\theta - mg = 0$

$T_2 \cos\theta = mg$

$T_2 = \frac{mg}{\cos\theta}$

X-DIMENSION

$F = ma$

$T_1 + T_2 \sin\theta = m \cdot \omega^2 R$

$T_1 = m\omega^2 R - T_2 \sin\theta$

$= m\omega^2 R - \left[\frac{mg}{\cos\theta}\right] \sin\theta$

$= m\omega^2 R - mg \tan\theta$

b. LET $T_1 = 0$

$0 = m\omega^2 R - mg\tan\theta$

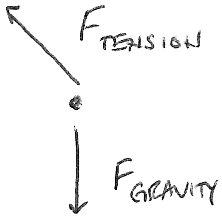
$mg\tan\theta = m\omega^2 R$

$\omega^2 = \frac{g\tan\theta}{R}$

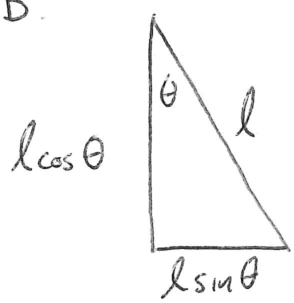
$\omega = \sqrt{\frac{g\tan\theta}{R}}$

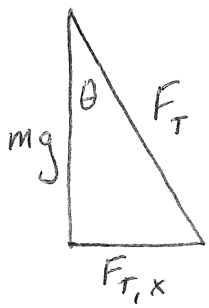
1978 m 1

a.



b.





$$m\omega^2 R = F_{T,x}$$

$$m\omega^2\left[A + l\sin\theta\right] = mg\tan\theta$$

$$\omega^2 = \frac{g\tan\theta}{A + l\sin\theta}$$

$$\omega = \sqrt{\frac{g\tan\theta}{A + l\sin\theta}}$$

c. $W = \Delta K$

$$W_m + W_G = \Delta K$$

$$W_m + \left[-\Delta U_G\right] = \Delta K$$

$$W_m = \Delta K + \Delta U_G$$

$$= 6\left[\tfrac{1}{2}mv^2\right] + 6\left[mgh\right]$$

WHERE $v = \omega R = \omega(A + l\sin\theta)$

$h = l(1-\cos\theta)$

$$= 3m\left[v^2\right] + 6mgl\left[1-\cos\theta\right]$$

1979 M3

a. $m\omega^2 R = k(\ell_2 - \ell_1)$

$m\omega^2 \ell_2 = k(\ell_2 - \ell_1)$

$m\omega^2 \ell_2 - k\ell_2 = -k\ell_1$

$\ell_2(m\omega^2 - k) = -k\ell_1$

$$\ell_2 = \frac{k\ell_1}{k - m\omega^2}$$

b. $E = K + U$

$= \frac{1}{2}mv^2 + \frac{1}{2}k(\ell_2 - \ell_1)^2$

$= \frac{1}{2}m(\ell_2\omega_0)^2 + \frac{1}{2}k\left[\ell_2 - \ell_1\right]^2$

$$= \frac{1}{2}m\left[\frac{k\ell_1}{k - m\omega_0^2}\right]^2\omega_0^2 + \frac{1}{2}k\left[\left(\frac{k\ell_1}{k - m\omega_0^2}\right) - \ell_1\right]^2$$

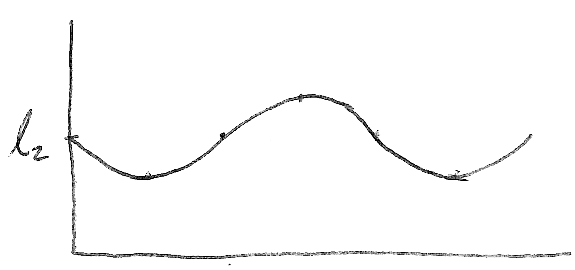
c. $L = rmv$

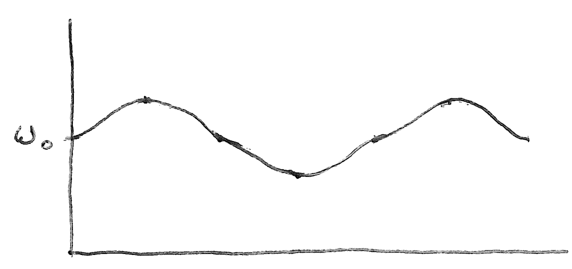
$= \ell_2 m(\omega_0 \ell_2)$

$= m\omega_0 \ell_2^2$

$$= m\omega_0\left[\frac{k\ell_1}{k - m\omega_0^2}\right]^2$$

d.





1983 m3

a. i. $K = mgh$

$= mg(R - R\cos\theta)$

$= mgR(1-\cos\theta)$

ii. $a_c = \frac{v^2}{R} = \frac{2K}{mR}$

$= 2g(1-\cos\theta)$

iii. AS FOR AN INCLINE,

$a = g\sin\theta$

b. IT LEAVES WHEN THE RADIALLY INWARD COMPONENT OF GRAVITY IS LESS THAN THE CENTRIPETAL FORCE.

$mg\cos\theta < m \cdot 2g(1-\cos\theta)$

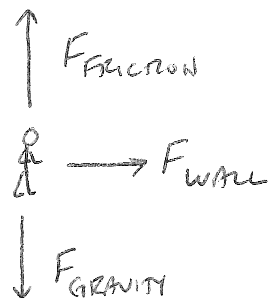
$mg\cos\theta < 2mg - 2mg\cos\theta$

$3mg\cos\theta < 2mg$

$\theta < \cos^{-1}\left(\frac{2}{3}\right)$

1984 M1

a.



b.

$$F_c = m \cdot \omega^2 R$$
$$= (50)(2^2 \cdot 5)$$
$$= 1000\,N$$ FROM THE WALL

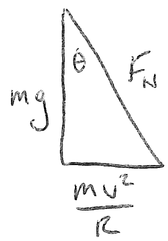
c. $F_{UPWARD} = mg$

$$= (50)(10) = 500\,N$$ FROM STATIC FRICTION

d. NO, THE GRAVITATIONAL FORCE WOULD DOUBLE, BUT SO WOULD THE NORMAL FORCE AND THUS THE FORCE OF STATIC FRICTION.

1988 M1

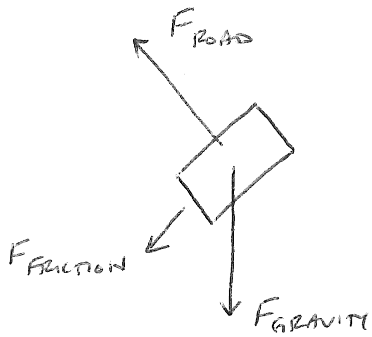
a.



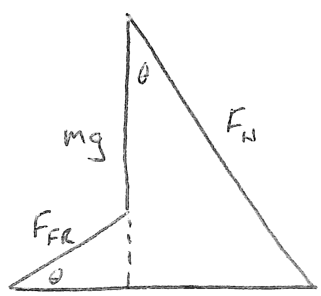
$$\tan\theta = \frac{mv^2/R}{mg} = \frac{v^2}{Rg}$$

$$v = \sqrt{Rg\tan\theta} = 16.2\ m/s$$

b.



c.



$$F_{FR}\cdot\cos\theta + F_N\sin\theta = \frac{mv^2}{R} \qquad mg + F_{FR}\sin\theta = F_N\cos\theta$$

$$0.966F_{FR} + 0.26F_N = 6.25m \qquad 9.8m + 0.26F_{FR} = 0.966F_N$$

$$1.515F_{FR} + 0.408F_N = 9.8m = 0.966F_N - 0.26F_{FR}$$

$$1.775F_{FR} = 0.558F_N$$

$$F_{SF} \le \mu F_N$$

$$1.775(\mu F_N) = 0.558F_N$$

$$\mu = 0.31$$

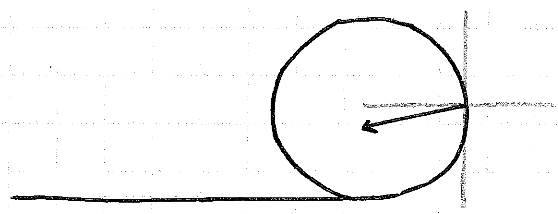
2014 M2

a. $mgh = \frac{1}{2}mv_0^2$

$$h = \frac{v_0^2}{2g}$$

b. i. ZERO, IT IS NOT ACCELERATING VERTICALLY

ii.



THE WALL PUSHES THE BLOCK TOWARD THE CENTER OF THE CIRCLE WITH A CENTRIPETAL FORCE. IT ALSO APPLIES A DRAG FORCE OF FRICTION ANTIPARALLEL TO THE VELOCITY.

c. $N = \frac{mv^2}{R}$

d. $a_T = \frac{\mu N}{m} = \frac{\mu v^2}{R}$

e. $\frac{dv}{dt} = \frac{-\mu v^2}{R}$

$$\frac{1}{v^2}dv = \frac{-\mu}{R}dt$$

$$\int v^{-2}dv = \int -\frac{\mu}{R}dt$$

$$\left.\frac{-1}{v}\right]_{v_0}^{v} = \left.\frac{-\mu}{R}\right]_0^t$$

$$-\frac{1}{v} + \frac{1}{v_0} = \frac{-\mu t}{R}$$

$$v = \frac{Rv_0}{R + \mu v_0 t}$$