STAEDTLER® No. 937 811E Engineer's Computation Pad

60 Figure 6-48 shows a *conical pendulum*, in which the bob (the small object at the lower end of the cord) moves in a horizontal circle at constant speed. (The cord sweeps out a cone as the bob rotates.) The bob has a mass of 0.040 kg, the string has length L = 0.90 m and negligible mass, and the bob follows a circular path of circumference 0.94 m. What are (a) the tension in the string and (b) the period of the motion?

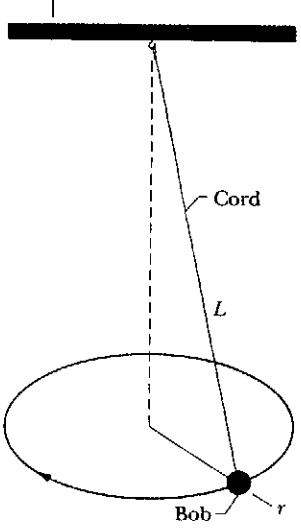
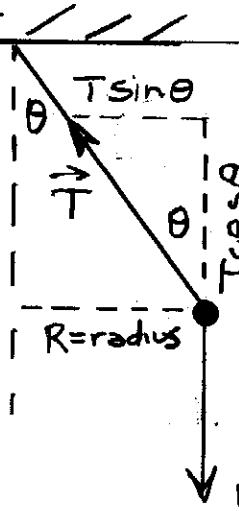


FIG. 6-48 Problem 60.



L = LENGTH OF STRING
R = RADIUS = $C/2\pi$
$\sin\theta = \frac{R}{L} = \frac{C}{2\pi L}$

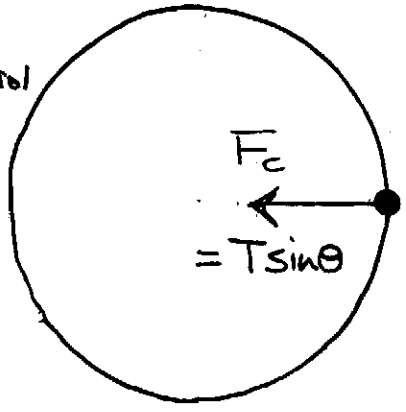
$\vec{F}^{net}_{on\,m} = m\vec{a}_{of\,m}$ & $\vec{F}^{net} = \vec{T} + \vec{mg}$

VERTICAL COMPONENT: $F_v = ma_v \equiv 0 \Rightarrow F_v = T_v + (-mg) = 0$

$\Rightarrow F_v = T\cos\theta - mg = 0 \Rightarrow T = mg/\cos\theta$

RADIAL COMPONENT:

$F^{net}_{radial} = m a_{radial} = m a_{centripetal}$



$\Rightarrow T\sin\theta = m\frac{v^2}{R}$

$v = \frac{2\pi R}{T} = \frac{\text{Circumference}}{\text{PERIOD}}$

$\Rightarrow \frac{mg}{\cos\theta}\sin\theta = m\left(\frac{2\pi R}{T}\right)^2 \frac{1}{R}$

$g\tan\theta = 4\pi^2 R/T^2$

$T = \sqrt{4\pi^2 R/g\tan\theta}$ (NOTE: for θ small & in RADIANS $\theta \approx \sin\theta \approx \tan\theta = R/L$ $= 2\pi\sqrt{L/g}$)

$\sin\theta = R/L = C/2\pi L = 0.94/(2\pi(0.90)) = 0.166$

$\cos\theta = \sqrt{1-\sin^2\theta} = 0.986 \Rightarrow \tan\theta = \frac{\sin\theta}{\cos\theta} = 0.168$

$R = C/2\pi = 0.94/2\pi = 0.150$

$\therefore T = mg/\cos\theta = 0.040(9.80)/0.986 = 0.398\ N$

$T = \sqrt{4\pi^2(0.150)/(9.80 * 0.168)} = 1.90$ sec

THE SUBJECT OF HOROLOGY STUDIED BY HOROLOGISTS