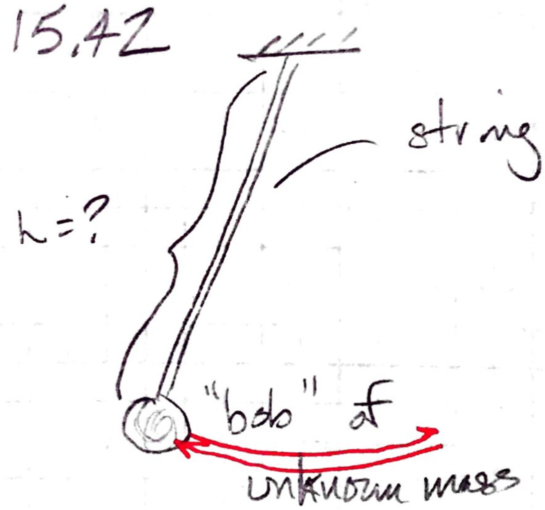
15.42



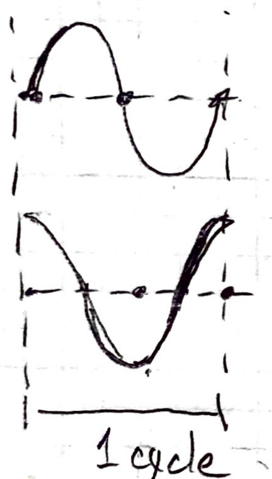
Period T = time for one swing "there" & back!

$$T_p = 2\pi\sqrt{\frac{L}{g}}$$ (equation sheet!)

$$T^2 = 4\pi^2 \frac{L}{g}$$

$$L = \frac{T^2 g}{4\pi^2} = \frac{(0.5s)^2(9.8 m/s^2)}{4\pi^2}$$

$$= \boxed{0.062 m}$$



15.49 $T = 2.00000\ s$ where $g = 9.80\ m/s^2$

When T at new location is $1.99796\ s$, what is g?

$$T = 2\pi\sqrt{\frac{L}{g}}$$

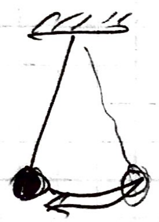
L constant, so

$$T^2 = \frac{4\pi^2 L}{g}, \text{ or } L = \frac{T^2 g}{4\pi^2}$$

$$\frac{T_1^2 g_1}{\cancel{4\pi^2}} = \frac{T_2^2 g_2}{\cancel{4\pi^2}}$$

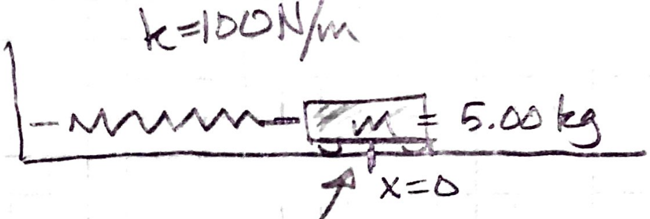
$$g_2 = \frac{T_1^2}{T_2^2} g_1$$

$$g_2 = \frac{(2)^2}{(1.99796)^2}(9.8) = \boxed{9.82\ m/s^2}$$

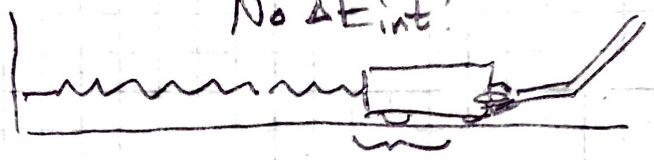


Does this make sense? Slightly higher gravity pulls down on pendulum more strongly, reducing the time it takes to complete a full swing.

15.60



No ΔE_{int}!



x= 0.04m

Student displaces cart 4.00 cm.

When cart is released it oscillates back & forth about the equilibrium.

a.) Equations of motion?

$A = 4\,cm = 0.04\,m$

ω (angular frequency) is determined by knowing that

$$T_s = 2\pi\sqrt{\frac{m}{k}}, \quad \& \quad T = \frac{2\pi}{\omega}$$

So, $x = A\cos(\omega t + \phi)$ $\quad \omega = \sqrt{\frac{k}{m}}$

$$x = (0.040)\cos\left(\sqrt{\frac{100}{5}}\,t + 0\right)$$

$$x = \boxed{0.040\cos(4.47t)}$$

$$v = -\omega A\sin(\omega t + \phi)$$

$$v = \boxed{-0.179\sin(4.47t)}$$

$$a = -\omega^2 x$$

$$= \boxed{-0.799\cos(4.47t)}$$

b) Plug in t = 3.00s for these equations to get

$$\boxed{\begin{aligned} x &= 0.0266\ m \\ v &= 0.134\ m/s \\ a &= 0.531\ m/s^2 \end{aligned}}$$