P1250 Hand-in Homework #7 Due Date: 11/6/2022

See the HiHW grading rubric posted on Carmen

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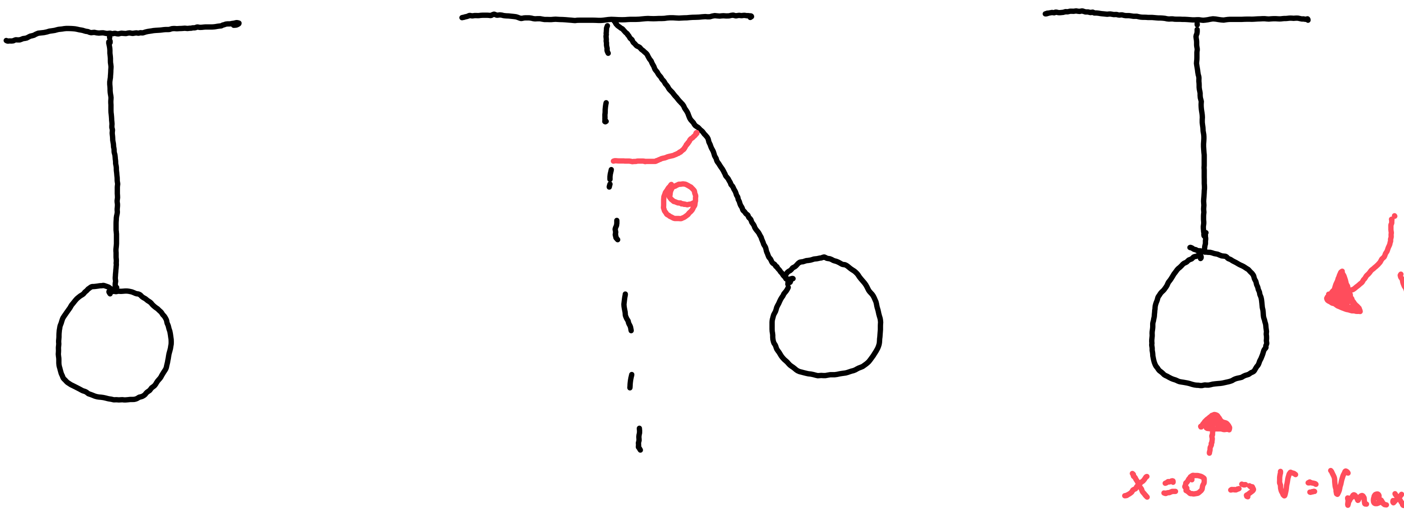
A bowling ball is suspended from the ceiling using a light string. While the string is taut, the ball is pulled back so that the string makes an angle of $\theta = 6.5°$ with respect to the vertical, and then the ball is released from rest. The resulting period of oscillation is $T = 3.3\,\text{s}$. What is the speed of the bowling ball at the bottom of its swing? For the limit check, investigate what happens to the ball's speed at the bottom if it is barely pulled back at all before being released ($\theta \to 0$).

Representation:	0	1	2
Physics Concept(s):	0	1	2
Initial Equation(s):	0	0.5	1
Symbolic Answer:	0		1
Units Check:	0	0.5	1
Limits Check:	0	0.5	1
Neatness:	-2	-1	0
Total:			
Correct Answer:	Y	N	

Representation



Physics Concept(s) (Refer to the list posted on Carmen)

(1) Simple Harmonic Motion

(2) Oscillations

Initial Equations

$\omega T = 2\pi$

$v_{max} = \omega A$

$\omega = \sqrt{\frac{g}{\ell}}$ $\quad mgh = \frac{1}{2}mv^2$

↓ Show Your Equation Work On Next Page ↓

Algebra Work (Symbols only. Don't plug in any numbers yet.)

$$V_{max} = \omega A \qquad KE = \frac{1}{2}mV^2 = \frac{1}{2}m(\omega A)^2$$

$$\omega = \frac{2\pi}{T} = \sqrt{\frac{g}{L}} \qquad \frac{g}{L} = \left(\frac{2\pi}{T}\right)^2 \qquad L = g\left(\frac{T}{2\pi}\right)^2$$

$$\cancel{m}g \cdot g\left(\frac{T}{2\pi}\right)^2(1-\cos\theta) = \frac{1}{2}\cancel{m}(\omega A)^2$$

$$2g^2\left(\frac{T}{2\pi}\right)^2(1-\cos\theta) = (\omega A)^2$$

$$\omega A = \sqrt{2(1-\cos\theta)} \cdot \frac{gT}{2\pi} \qquad A = \frac{\sqrt{2(1-\cos\theta)} \cdot \frac{gT}{2\pi}}{\omega}$$

$$V_{max} = \omega A = \cancel{\omega} \cdot \frac{\sqrt{2(1-\cos\theta)} \cdot \frac{gT}{2\pi}}{\cancel{\omega}}$$

Symbolic Answer: $V_{max} = \sqrt{2(1-\cos\theta)} \cdot \frac{gT}{2\pi}$

Units Check

$$\frac{m}{s} = \frac{m}{s^{\cancel{2}}} \cdot \cancel{s} = \frac{m}{s} \quad \checkmark$$

Limits Check

a) As $\theta \to 0$, what limit does v approach?

$$\lim_{\theta \to 0} v = 0$$

b) Why does the result make physical sense?

Without angle, the ball would gain no potential energy and thus no kinetic energy or velocity

Numerical Answer: (Obtain this by plugging numbers into your symbolic answer.)

$$2(1-\cos(6.5)) \cdot \frac{9.8(3.3)}{2\pi} = 0.24101 \text{ m/s}$$