AP Physics Oscillations

① $\frac{1}{2\pi}\sqrt{\frac{k}{m}}$; $\frac{1}{2\pi}$ is unitless, k has units N/m, m has units of kg so....

$$\sqrt{\frac{N/m}{kg}} = \sqrt{\frac{N}{kg\,m}} = \sqrt{\frac{\frac{kg\,m}{s^2}}{kg\,m}} = \sqrt{\frac{kg\cdot m}{kg\,m\,s^2}} = \sqrt{\frac{1}{s^2}} = \frac{1}{s} = Hz$$

is the correct unit for f

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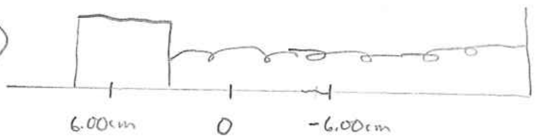
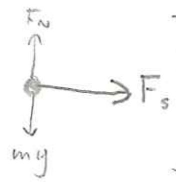
②



starts at +max ⇒ cosine for $\vec{x}$ vs t

⇒ $\vec{a}$ starts at −max ⇒ −cosine for $\vec{a}$ vs t



$\Sigma \vec{F}_x = m\vec{a}$

$kA = m a_{max}$

$a_{max} = \frac{kA}{m} = 13.18\ m/s^2$

$$\vec{a} = -\frac{Ak}{m}\cos\left(\sqrt{\frac{k}{m}}\,t\right)$$

$\vec{a} = 12.11\ m/s^2$

$\omega = \sqrt{\frac{k}{m}}$

$\vec{a} = 12.1\ m/s^2$ in direction of original displacement

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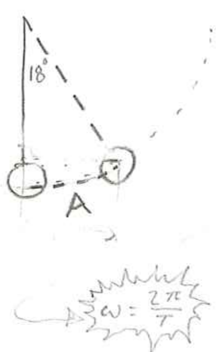
③



a. $V_{max} = A\omega = L\theta\sqrt{\frac{g}{L}} = \sqrt{Lg}\ \theta$ → radians

$V_{max}^2 = Lg(\theta)^2$

$\theta = 18°\left(\frac{\pi}{180°}\right) = \frac{\pi}{10}$

$L = \frac{V_{max}^2}{g\left(\frac{\pi}{10}\right)^2} = 1.884263849\ m$

$T = 2\pi\sqrt{\frac{L}{g}} = 2.755102041\ s$

$T = 2.76\ s$

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b. $A = L\theta$; 0.591958946 m

OR $A = \frac{V_{max}}{\omega} = \frac{V}{\sqrt{\frac{g}{L}}} = V\sqrt{\frac{L}{g}} = 0.591958946\ m$

$t = 0\,s$ is max displacement ⇒ cosine.
(Assume positive)

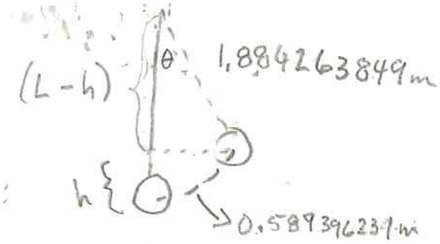
$\vec{x} = A\cos(\omega t)$

$\vec{x} = 0.591958946\cos\left(\frac{2\pi}{T}22\right)$

$\vec{x} = 0.5893962311\ m$

$\vec{x} = 0.589\ m$ (s[illegible])

$\theta = \frac{x}{L}$; $\theta = 0.312799203$ rad



$\cos\theta = \frac{L-h}{L}$

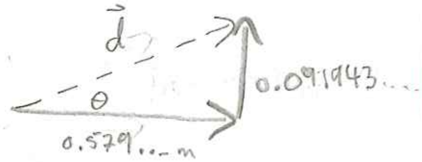
$L - h = 1.792831677$ m

$h = 0.09143217$ m

SHM approximation

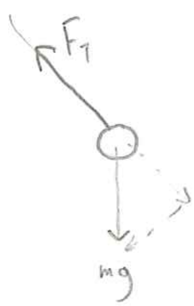
$d_x = (L-h)\tan\theta$

$d_x = 0.579329614$ m



$\vec{d} = 0.587\text{m}$ @ $9.12°$ above x

c.



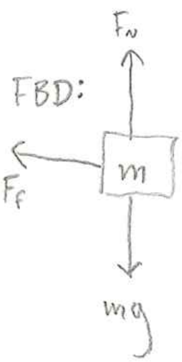
$a_c = 0\,m/s^2 \Rightarrow F_T = mg\cos\theta = mg\cos 18° = 14.0\text{ N}$

because $v = 0\,m/s$!!

4) F_f keeps m in place, and causes its acceleration!

Consider the right-hand max position

FBD:



$\Sigma\vec{F} = ma$

$F_{f_{max}} = \mu mg = ma_{max}$

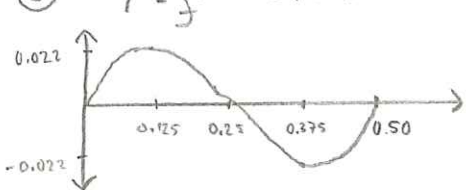
$a_{max} = \mu g$

→ Since the two blocks move together a_{max} for m is a_{max} for SYSTEM of $(M+m)$

$F_{max} = kx_{max} = kA = (M+m)a$

$A = \frac{(M+m)\mu g}{k} = 0.21\text{m}$

⑤ $T = \frac{1}{f} = 0.50\text{s}$ $A = 0.022\text{m}$



b) i 0 s
ii 0.25 s

c) 0 s, 0.25 s

d) i. 0.375 s ≃ 0.38 s
ii. 0.125 s ≃ 0.13 s