Trevor + Katherine Lab 6 SHM PHYS121-118 Station 15+16 Phillip

$F = -k(\Delta x)$

$a = \frac{-k\Delta x}{m}$

$-k\Delta x = m\ddot{x}$

$\begin{cases} x = x_m \sin(\omega t + \phi) + x_0 \\ \omega = \sqrt{k_s/m} \end{cases}$

$\tau = -k_t\theta$

$\tau = I\alpha$

$-k_t\theta = I\alpha$

$\theta = \theta_m \sin(\omega t + \phi)$, $\omega = \frac{2\pi}{T}$, $\omega = \sqrt{k_t/I}$

$k_t = \frac{\pi A^2}{2\pi L}$

Rotational SHM

$L = 0.9850 \pm 0.0005$ m

$d_p = 0.2685 \pm 0.0005$ m

$d_r = 0.0045 \pm 0.0002$ m

$m = 4.7 \pm 0.1$ kg

Experimental values:

$T = 0.99836 \pm 0.0023$ s

$= 0.998 \pm 0.003$ s

$I = \frac{1}{2}m\left(\frac{d_p}{2}\right)^2$

$\frac{2\pi}{T} = \sqrt{k_t/I}$

$I 4\pi^2 = T^2 k_t$

$\frac{\frac{1}{2}md_p^2\pi^2}{T^2} = k_t$

$\frac{md_p^2\pi^2}{2T^2} = \frac{n\left(\frac{d_r}{2}\right)^4\pi^2}{2\pi L}$

$\boxed{\frac{16md_p^2L\pi}{d_r^4T^2} = n}$

$\delta_n = \sqrt{\delta_{nm}^2 + \delta_{nd_p}^2 + \delta_{nL}^2 + \delta_{nd_r}^2 + \delta_{nT}^2}$

$= \left(\left(\delta_m \frac{16d_p^2L\pi}{d_r^4T^2}\right)^2 + \left(\delta_{d_p}\frac{32md_pL\pi}{d_r^4T^2}\right)^2 + \left(\delta_L\frac{16md_p^2\pi}{d_r^4T^2}\right)^2 + \left(\delta_{d_r}\frac{64md_p^2L\pi}{d_r^5T^2}\right)^2 + \left(\delta_T\frac{32\pi md_p^2L\pi}{d_r^4T^3}\right)^2\right)^{1/2}$

$= \left(\left(\frac{\delta_m}{m}\right)^2 + \left(\frac{2\delta_{d_p}}{d_p}\right)^2 + \left(\frac{\delta_L}{L}\right)^2 + \left(\frac{4\delta_{d_r}}{d_r}\right)^2 + \left(\frac{2\delta_T}{T}\right)^2\right)^{1/2} \frac{16md_p^2L\pi}{d_r^4T^2}$

Need to recalculate with Std. Err.

$n = 4.104579 \times 10^{10} \pm 9.2 \times 10^8$

$\boxed{(4.10 \pm 0.09) \times 10^{10}}$

Translational SHM

$x = A\sin(Bt + C) + D$

$m = 0.10008 \pm 0.00001$ kg
$m_2 = 0.1100 \pm 0.0001$
Estimated
$max = 0.557$
$am_1 = 0.1225$
$T = 1.13625$
$\phi = 0.1549375$

	A (m)	B (s^{-1})	C	D (m)	RMSE (m)	cor
1)	0.1133 ± 0004	5.536 ± 0.001	5.277 ± 0.006	0.4321 ± 0.0003	0.005622	0.9990
2	0.09770 ± 0.0002	5.541 ± 0.0008	5.623 ± 0.004	0.4316 ± 0.0002	0.002326	0.9994
3	0.1118 ± 0.0002	5.539 ± 0.0006	5.291 ± 0.003	0.4301 ± 0.0001	0.001916	0.9997
4	0.1354 ± 0.0003	5.538 ± 0.0006	4.778 ± 0.004	0.4303 ± 0.0002	0.002528	0.9997
5	0.1580 ± 0.0003	5.537 ± 0.0007	4.124 ± 0.004	0.4303 ± 0.0002	0.003212	0.9996
10 cm	0.2240 ± 0.0006	5.536 ± 0.0009	3.156 ± 0.005	0.4303 ± 0.0004	0.005793	0.9994
+10g	0.2144 ± 0.0008	5.285 ± 0.001	2.431 ± 0.008	0.4032 ± 0.0006	0.008438	0.9985

$k_s = \omega^2 m$

$\bar{B}\begin{cases} \sigma = 0.0019\ s^{-1} \\ SE = 0.0009\ s^{-1} \\ \omega = 5.539 \pm 0.0006\ s^{-1} \end{cases}$

$\delta k_s = \left(\left(\frac{2\delta\omega}{\omega}\right)^2 + \left(\frac{\delta m}{m}1\right)^2\right)^{1/2} \omega^2 m$

$\boxed{k_s = 3.068 \pm 0.003\ \frac{kg}{s^2}}$

$\omega_{2e} = \sqrt{\frac{k_s}{m_2}}$

$\delta\omega_{2e} = \left(\left(\frac{\frac{1}{2}\delta k_s}{k_s}\right)^2 + \left(\frac{\frac{1}{2}\delta m_2}{m_2}\right)^2\right)^{1/2} \sqrt{\frac{k_s}{m_2}}$

$\boxed{\omega_{2e} = 5.282 \pm 0.004\ s^{-1}}$ 4 falls