The Chinese University of Hong Kong, Shenzhen

PHY 1002

Physics Laboratory

Short Report: Rotational Inertia

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1 Rectangular Bar Pendulum: Minimum Period

1.1 $x - T$ Plot

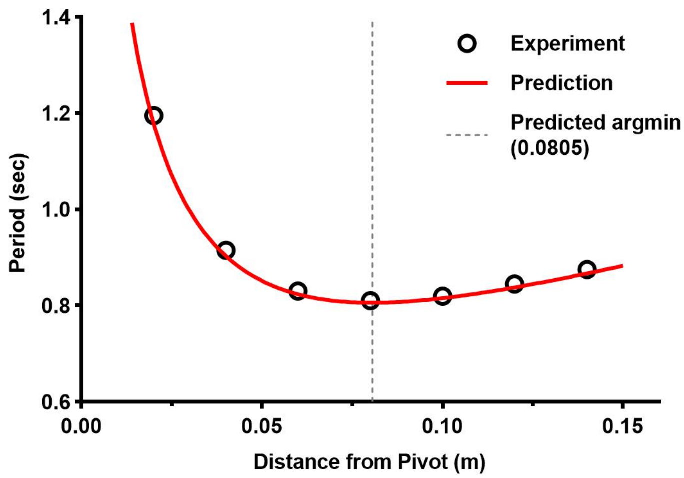

Figure 1: Relationship of pivot-CM distance x and period of the pendulum T

1.2 Minimum Period

The following table records x_0 (x that gives the minimum period) and $T_{\min}$, obtained both from the experiment and theory. The percentage differences of the experimental values from predictions are calculated for comparison.

	Experiment	Prediction	Relative Difference
x_0 (cm)	8.00	8.05	-0.62%
$T_{\min}$ (s)	0.810	0.807	$+0.37\%$

Table 1: Values of x_0 and corresponding minimum period $T_{\min}$

The experimental values fit well with our theory.

2 Rotational Inertia of a Disk

2.1 Raw Data

$$T = 0.494 \pm 0.001 \text{ s}$$
$$M = 89.37 \pm 0.02 \text{ g}$$
$$d = R = 4.0 \pm 0.1 \text{ cm}$$
$$g = 9.78 \pm 0.01 \text{ N} \cdot \text{kg}^{-1}$$

2.2 Rotational Inertia about CM

The experimental value of rotational inertia about CM is given by

$$I_{\text{exp}} = \frac{T^2 Mgd}{4\pi^2} - Md^2 = (7.31 \pm 0.20) \times 10^{-5} \text{ kg} \cdot \text{m}^2$$

and the theoretical value given by

$$I_{\text{theo}} = \frac{1}{2} MR^2 = (7.15 \pm 0.36) \times 10^{-5} \text{ kg} \cdot \text{m}^2$$

with a relative difference of

$$\frac{I_{\text{exp}} - I_{\text{theo}}}{I_{\text{theo}}} = 2.24 \text{ \%}$$

3 Rotational Inertia of an Irregular Pendulum

3.1 Raw Data

$$M = 10.07 \pm 0.02 \text{ g}$$
$$r = 1.4 \pm 0.1 \text{ cm}$$
$$g = 9.78 \pm 0.01 \text{ N} \cdot \text{kg}^{-1}$$

3.2 $t - \omega$ Plot and I_{CM} of the Irregular Pendulum

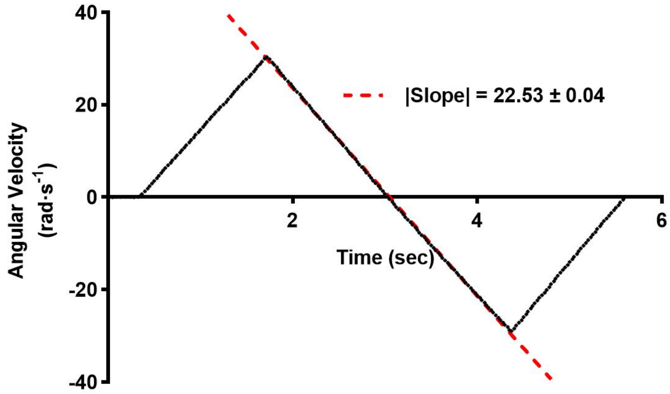

Figure 2: Relationship of angular velocity ω and time t

A linear regression of the $t - \omega$ curve during one period of acceleration yields

$$\alpha = |\dot{\omega}| = 22.53 \pm 0.04 \text{ rad} \cdot \text{s}^{-2}$$

The rotational inertia of the irregular pendulum about its CM can be found, via

$$I_{\mathrm{CM}} = Mr\left(\frac{g}{\alpha} - r\right) = (5.92 \pm 0.41) \times 10^{-5} \text{ kg} \cdot \text{m}^2$$