BALLISTIC PENDULUM EXPERIMENT

Medium Range Projectile Motion Trials

Mean Range

$$R_{avg} = \frac{1}{N}\sum_{i=1}^{N} x_i$$

$$R_{avg} = \frac{1}{2}\sum_{i=1}^{2} x_i = \frac{1}{2} * (147.61\text{ cm} + 148.81\text{ cm})$$

$$R_{avg} = 148.21\text{ cm}$$

Range Uncertainty

$$\delta R = \frac{\sigma}{\sqrt{N}} \qquad \sigma = \sqrt{\frac{\sum_{i=1}^{N}(x - x_i)^2}{N-1}} = \sqrt{\frac{(148.21\ cm - 147.61 cm)^2 + (148.21\ cm - 148.81 cm)^2}{2-1}} = 0.84852\text{ cm}$$

$$\delta R = \frac{0.84852\ cm}{\sqrt{2}}$$

$$\delta R = 0.60000\text{ cm}$$

Initial Speed

$$v_0 = \frac{R_{avg}}{\sqrt{\frac{2\Delta y}{a}}}$$

$$v_0 = \frac{148.21\ cm}{\sqrt{\frac{2(83.50\ cm)}{980\ cm/s^2}}}$$

$$v_0 = 359\text{ cm/s}$$

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Initial Speed Uncertainty

$$\delta v_0 = \text{f(x,y)} * \sqrt{\left(\frac{n*\delta x}{x}\right)^2 + \left(\frac{m*\delta y}{y}\right)^2}$$

$$\delta v_0 = 359 \text{ cm/s} * \sqrt{\left(\frac{1*0.60000\ cm}{148.21\ cm}\right)^2 + \left(\frac{\frac{1}{2}*0.05}{0.413}\right)^2}$$

$$\delta v_0 = 21.8 \text{ cm/s}$$

Medium Range Pendulum Arm with No Masses Attached Trials

Initial Kinetic Energy

$$K_0 = \frac{1}{2} \text{m} v_0^{\ 2}$$

$$K_0 = \frac{1}{2} * 0.207 \text{ kg } * (3.59\ m/s)^2$$

$$K_0 = 0.372 \text{ J}$$

Initial Kinetic Energy Uncertainty

$$\delta K_0 = \text{f(x,y)} * \sqrt{\left(\frac{n*\delta x}{x}\right)^2 + \left(\frac{m*\delta y}{y}\right)^2}$$

$$\delta K_0 = 0.372 \text{ J} * \sqrt{\left(\frac{1*0.0001\ kg}{0.207\ kg}\right)^2 + \left(\frac{2*0.218\ m/s}{3.59\ m/s}\right)^2}$$

$$\delta K_0 = 0.0452 \text{ J}$$

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Final Gravitational Potential Energy

$$U_g = \text{mgy}$$

$$U_g = 0.2069\ \text{kg} * 9.80\ \text{m}/s^2 * (0.271\ \text{m} * \sin(44.9°))$$

$$U_g = 0.489\ \text{J}$$

Final Gravitational Potential Energy Uncertainty

$$\delta U_g = \sqrt{(\frac{\partial f(x,y)}{\partial x})^2(\delta x)^2 + (\frac{\partial f(x,y)}{\partial y})^2(\delta y)^2}$$

$$\delta U_g = \sqrt{(\frac{0.489\ J}{0.2069\ kg})^2(0.0001\ kg)^2 + (\frac{0.489\ J)}{0.191\ m})^2(0.0005\ m)^2}$$

$$\delta U_g = 0.00130\ \text{J}$$

Energy Percent Difference

$$PD = \left|\frac{E_1 - E_2}{\frac{E_1+E_2}{2}}\right| * 100\%$$

$$PD = \left|\frac{K_0 - U_g}{\frac{K_0+U_g}{2}}\right| * 100\%$$

$$PD = \left|\frac{0.372\ J - 0.489\ J}{\frac{0.372\ J+0.489\ J}{2}}\right| * 100\% = 27.2\%$$

BALLISTIC PENDULUM EXPERIMENT

TABLE OF RESULTS

PROJECTILE LAUNCHER SETTING	MEAN RANGE $R_{avg} \pm \delta R$ (cm)	INITIAL SPEED $v_0 \pm \delta v_0$ $\left(\frac{m}{s}\right)$
MEDIUM	148.21 ± 0.60000	3.59 ± 0.218
LONG	201.66 ± 0.28008	4.89 ± 0.295

ATTACHED BRASS MASSES	PROJECTILE LAUNCHER SETTING	CHANGE IN ENERGY		
		KINETIC ENERGY $K_0 \pm \delta K_0$ (J)	GRAVIATIONAL POTENTIAL ENERGY $U_g \pm \delta U_g$ (J)	PERCENT DIFFERENCE PD $(\%)$
NONE	MEDIUM	0.372 ± 0.0452	0.489 ± 0.00130	27.2
	LONG	0.506 ± 0.0611	0.490 ± 0.00104	3.21
BOTH	MEDIUM	0.562 ± 0.0683	0.397 ± 0.00154	34.4
	LONG	0.766 ± 0.0924	0.533 ± 0.00154	35.9