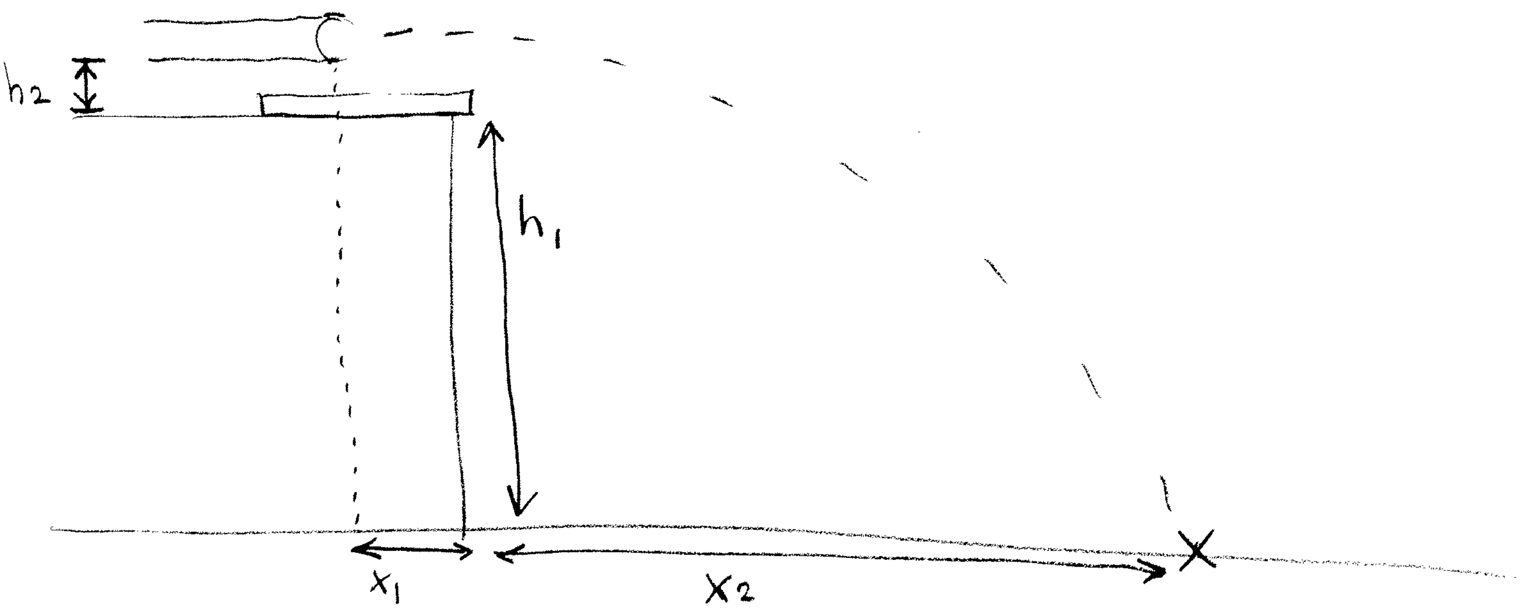
Pendulum device BP-45001.

12/6/2008



x_1	10.4 ± 0.3 cm	middle setting
x_2	140.6 ± 1.8 cm	3 trials
h_1	88.7 ± 0.2 cm	
h_2	5.9 ± 0.1 cm	

$X = x_1 + x_2 = 151.0 \pm 2.1$ cm $\qquad \frac{2.1 \text{ cm}}{150.0 \text{ cm}} = 0.014$

$H = h_1 + h_2 = 94.6 \pm 0.3$ cm $\qquad \frac{0.3 \text{ cm}}{94.6 \text{ cm}} = 0.003$

Use H to find t.

$$y(t) = H + 0t - 4.9t^2$$

$$\Rightarrow t = \sqrt{\frac{H}{4.9 \text{ m/s}^2}} = \sqrt{\frac{0.946 \text{ m}}{4.9 \text{ m/s}^2}} = 0.4394 \text{ s}$$

$$\frac{\Delta t}{t} = \frac{1}{2}\frac{\Delta H}{H} = \frac{1}{2}(0.003) = 0.0015$$

$$\Rightarrow \Delta t = 0.0015\,(0.4394 \text{ s}) = 0.0007 \text{ s}$$

$$\boxed{t = 0.4394 \text{ s} \pm 0.0007 \text{ s}}$$

Use $\bar{X}$ and t to find v.

$$\bar{X} = vt$$

$$\Rightarrow v = \frac{\bar{X}}{t} = \frac{151.0 \text{ cm}}{0.4394 \text{ s}} = 343.7 \text{ cm/s}$$

$$\frac{\Delta v}{v} = \frac{\Delta \bar{X}}{\bar{X}} + \frac{\Delta t}{t} = 0.014 + 0.0015 \cong 0.016$$

$$\Delta v = 0.016\,(343.7 \text{ cm/s}) = 5.5 \text{ cm/s}$$

$$\Rightarrow \boxed{v = 344 \pm 6 \text{ cm/s}}$$

What if we shoot ball from student table?

Now $h_1' = 73.8 \pm 0.2$ cm

$h_2 = 5.9 \pm 0.1$ cm (same as before)

$H' = 79.7 \pm 0.3$ cm $\frac{0.3}{79.7} = 0.004$

Time to fall to floor

$$t' = \sqrt{\frac{H'}{4.9\ m/s^2}} = \sqrt{\frac{0.797\ m}{4.9\ m/s^2}} = 0.4033\ s$$

$$\frac{\Delta t'}{t'} = \frac{1}{2}\frac{\Delta H'}{H'} = \frac{1}{2}(0.004) = 0.002$$

$$\Rightarrow \Delta t' = 0.002\,(0.4033\ s) = 0.0008\ s$$

$$\Rightarrow t' = 0.4033 \pm 0.0008\ s$$

Distance ball will travel horizontally should now be

$$X' = v t' = \left(344\ \tfrac{cm}{s}\right)(0.4033\ s) = 138.7\ cm$$

$$\frac{\Delta X'}{X'} = \frac{\Delta v}{v} + \frac{\Delta t'}{t'} = 0.016 + 0.002 = 0.018$$

$$\Rightarrow \Delta X = 0.018\,(138.7\ cm) = 2.5\ cm$$

$$\Rightarrow \boxed{X' = 138.7 \pm 2.5\ cm}$$

Now we place box on floor and mark paper at predicted landing point. The spot will be a distance x_2' from table, where

$$\underline{X}' = x_1 + x_2' \Rightarrow x_2' = \underline{X}' - x_1$$

$$= 138.7 - 10.4 \text{ cm}$$

$$= 128.3 \text{ cm from table}$$

	A	B	C
155.5 −	16.5	13	15.3
	= 139.0	142.5	140.2

$\mu = 140.6 \pm 1.8$ cm for X_2

Three trials, firing ball from middle setting, when on <u>teacher's</u> table

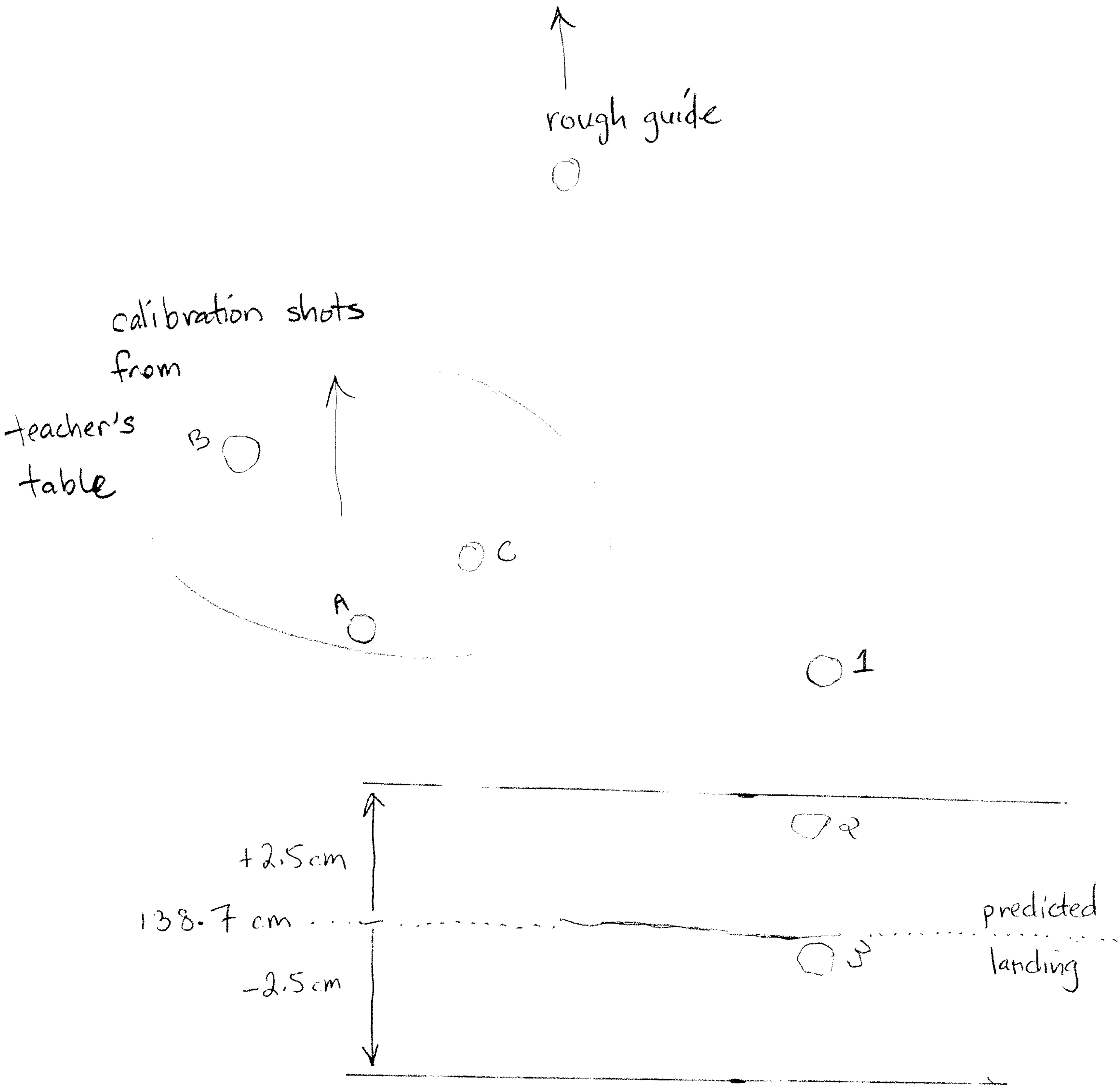
---

Three trials, firing ball from middle setting, when on <u>student</u> table.

actual	1	2	3
	143.3	140.6	138.3

$\mu = 140.7 \pm 2.5$ cm (actual) vs. 138.7 ± 2.5 cm (predicted)

Yes, consistent with prediction!


rough guide
calibration shots
from
teacher's
table
B
C
A
1
2
+2.5cm
138.7 cm
-2.5cm
3
predicted
landing