M4: Projectile Motion

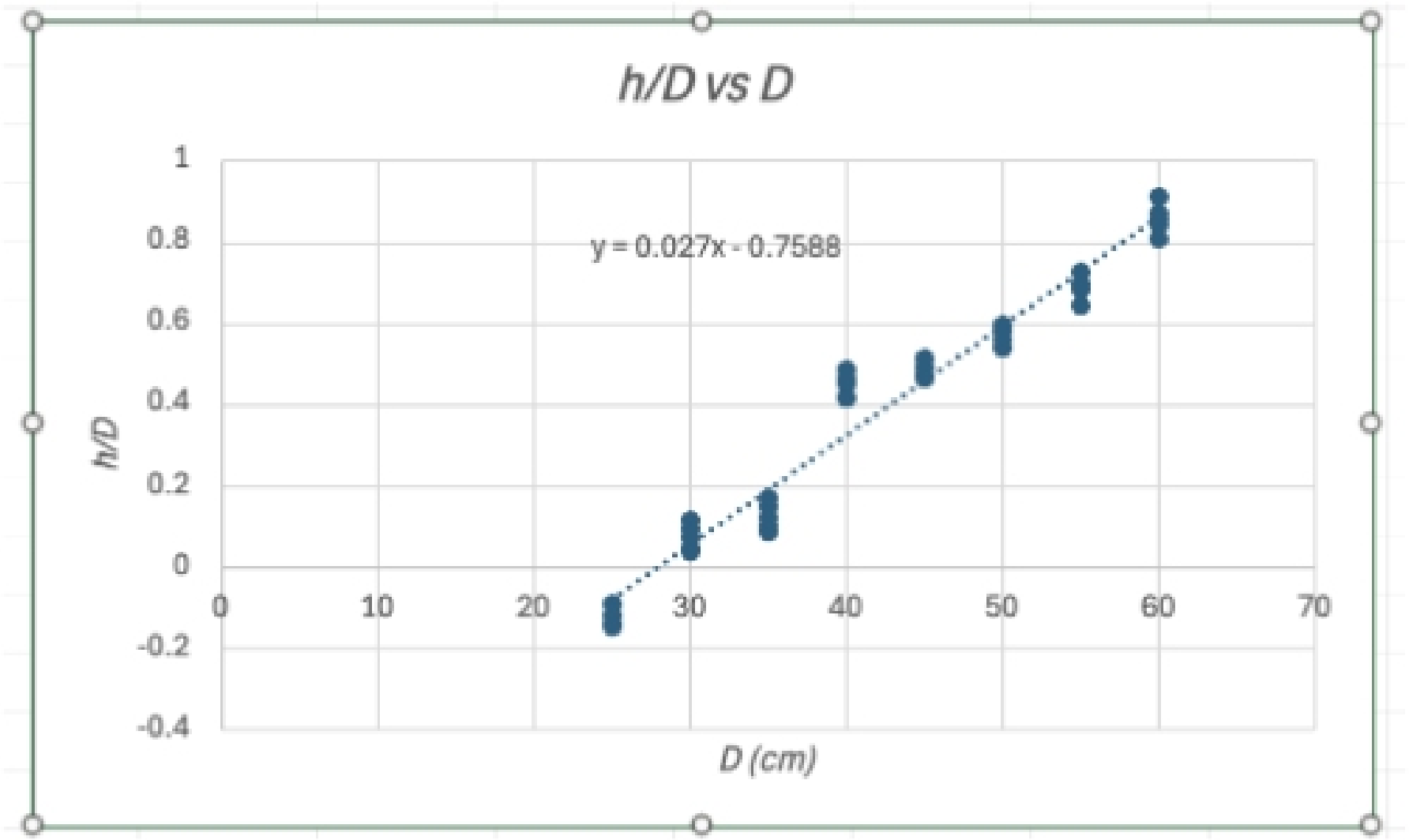
VI-1

D (cm)	h (cm)	h/D
25	-2.3	-0.092
25	-3.5	-0.14
25	-3.8	-0.152
25	-3.1	-0.124
25	-3.5	-0.14
30	1.2	0.04
30	1.3	0.043333333
30	2.2	0.073333333
30	2.7	0.09
30	3.4	0.113333333
35	3.1	0.088571429
35	3.4	0.097142857
35	4.2	0.12
35	5.1	0.145714286
35	5.8	0.165714286
40	16.5	0.4125
40	16.5	0.4125
40	18.1	0.4525
40	18.5	0.4625
40	19.4	0.485
45	21.0	0.466666667
45	21.1	0.468888889
45	21.2	0.471111111
45	22.0	0.488888889
45	23.0	0.511111111
50	27.0	0.54
50	27.1	0.542
50	28.0	0.56
50	28.9	0.578
50	29.7	0.594
55	35.5	0.645454545
55	37.5	0.681818182
55	37.7	0.685454545
55	38.4	0.698181818
55	40.0	0.727272727
60	48.4	0.806666667
60	50.4	0.84

60	51.2	0.853333333
60	52.0	0.866666667
60	54.5	0.908333333

Example: h/D - h (-2.3) divided by D (25) = -0.092. To receive the rest of the values, I placed the formula into excel.

VI-2



Equation: $h/D = 0.027D - 0.7588$

VI-3

Using LINEST on excel I found the slope s, uncertainty in the slope σ_s, the intercept b and the uncertainty in the intercept σ_b to be :
$s \pm \sigma_s = 0.026964 \pm 0.000869$ cm and $b \pm \sigma_b = -0.75877 \pm 0.038251$ cm.

Determine $\theta_e \pm \sigma\theta_e$:

$b = -\tan\theta_e \longrightarrow \theta_e = \tan^{-1}(-b) = \tan^{-1}(0.75877) = 37.190$

$$\sigma_{\theta e} = \frac{(\sigma_b)}{1+b^2} = \frac{(0.038251)}{(1+(-0.75877))^2} * (180^\circ/\pi)$$

$$= 1.391^\circ$$

$$\theta e \pm \sigma_{\theta e} \simeq 37^\circ \pm 1$$

$\theta_e \pm \sigma\theta e = 37 \pm 1$

Determine $\theta_m \pm \sigma\theta_m$:

$$\theta_m = (41 + 40 + 39)/3 = 40^\circ$$

$$\sigma_{\theta m} = (41-39)/2 = 1^\circ$$

$$\theta_m \pm \sigma_{\theta m} \simeq 40^\circ \pm 1^\circ$$

The proximity of the two values suggests that they agree with their uncertainty values. Although, calculated values are more precise and dependable than measured values. Measurements can be affected by external factors and are prone to errors, while calculated values are based on a wider data set, minimizing the chances of errors.