Flipping Physics Lecture Notes:

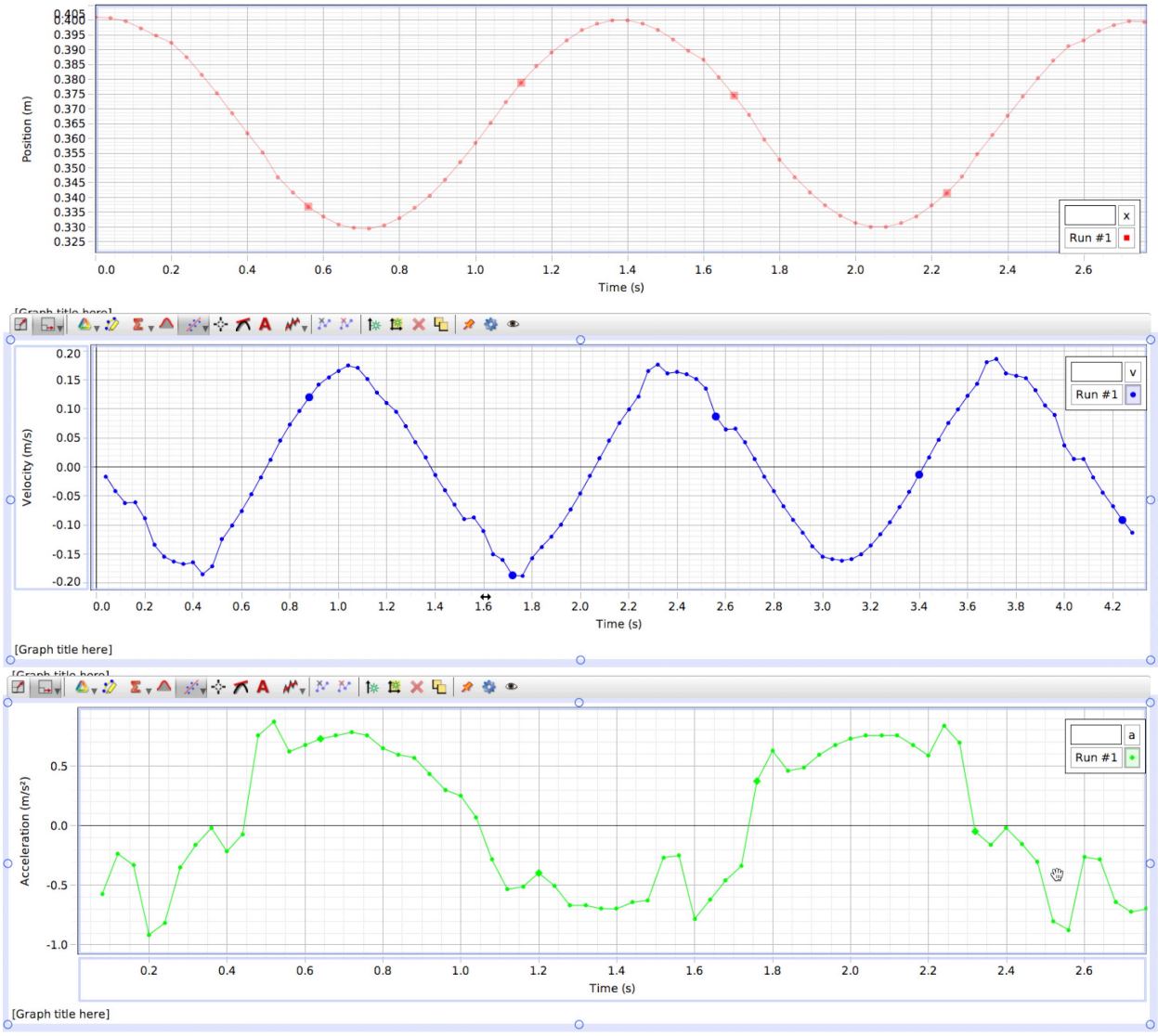
Demonstrating Position, Velocity, and Acceleration
of a Mass-Spring System

The basic equations of simple harmonic motion are:

$$y(t) = A\cos(\omega t + \phi);\ v(t) = -A\omega\sin(\omega t + \phi);\ a(t) = -A\omega^2\cos(\omega t + \phi)$$

For our demonstrations we are going to assume the phase constant, ϕ, is zero. This means there is no phase shift in our demonstration.

The position, velocity, and acceleration as a function of time graphs:



Determining the period using the time for two cycles: $2T = 2.72\,\text{sec} \Rightarrow T = \dfrac{2.72}{2} = 1.36\,\text{sec}$

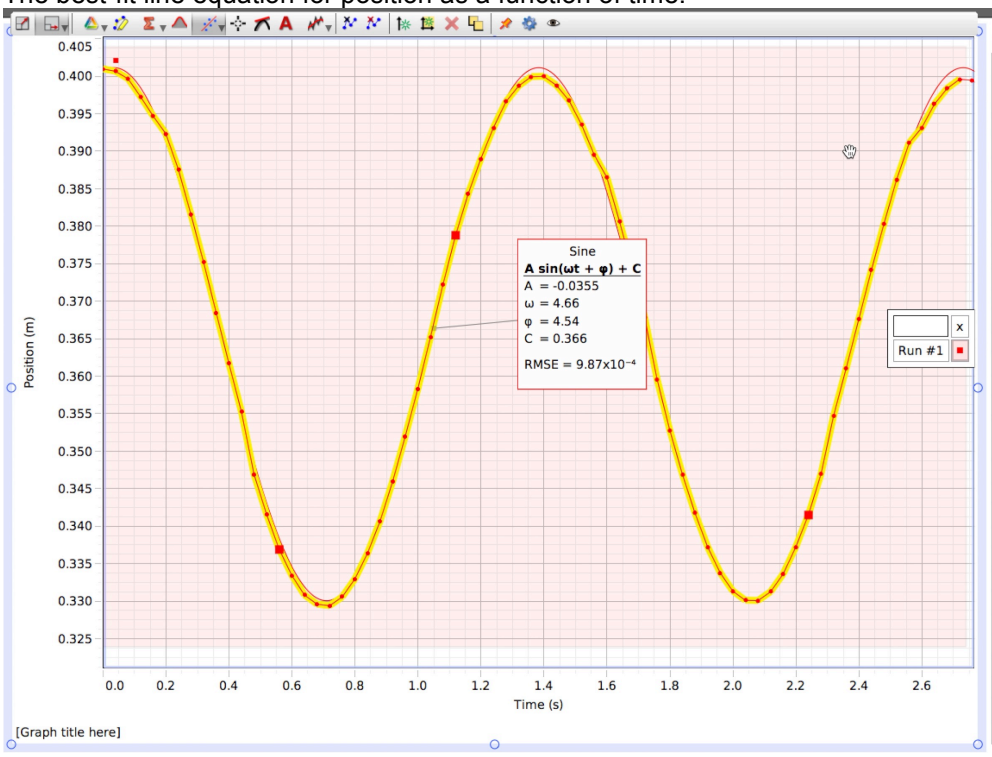
Determining the spring constant using the period and the mass:

$$T = 2\pi\sqrt{\frac{m}{k}} \Rightarrow T^2 = 4\pi^2\left(\frac{m}{k}\right) \Rightarrow k = \frac{4\pi^2 m}{T^2} \Rightarrow k = \frac{4\pi^2(0.305)}{1.36^2} = 6.5100 \approx 6.51\frac{N}{m}$$

$$m = 305g \times \frac{1kg}{1000g} = 0.305kg$$

Just so you know, the 305 grams includes the mass of the mass hanging.

The best-fit line equation for position as a function of time:



[Table title here]

	Run #1	
	Position (m)	Time (s)
45	0.359	1.760
46	0.353	1.800
47	0.347	1.840
48	0.342	1.880
49	0.337	1.920
50	0.334	1.960
51	0.331	2.000
52	0.330	2.040
53	0.330	2.080
54	0.331	2.120
55	0.334	2.160
56	0.337	2.200
57	0.341	2.240
58	0.347	2.280
59	0.355	2.320
60	0.361	2.360
61	0.368	2.400
62	0.374	2.440
63	0.380	2.480
64	0.386	2.520
65	0.391	2.560
66	0.393	2.600
67	0.396	2.640
68	0.398	2.680
69	0.400	2.720
70	0.399	2.760
71	0.398	2.800
72	0.396	2.840
73	0.393	2.880

Determining period using angular frequency, ω:

$$\omega = \frac{\Delta\theta}{\Delta t} = \frac{2\pi}{T} \Rightarrow T = \frac{2\pi}{\omega} = \frac{2\pi}{4.66} = 1.34832 \approx 1.35 \text{ sec}$$