

Problem 4: ~~Spring-mass harmonic oscillator~~

~~Consider an ideal spring that has an unstretched length l_0 . Assume the spring has a constant k . Suppose the spring is attached to a mass m that lies on a horizontal frictionless surface. The spring-mass system is compressed a distance of x_0 from equilibrium and then released with an initial speed v_0 toward the equilibrium position.~~

- ~~a) What is the period of oscillation for this system?~~
- ~~b) How long will it take for the mass to first return to the equilibrium position?~~
- ~~c) How long will it take for the mass to first become completely extended?~~
- ~~d) Draw a graph of the position and velocity of the mass as a function of time. Carefully label your axes and clearly specify any special values.~~

Problem 5: Analysis Experiment 06 Post

- a) Enter the values from your experiment into the table below.

a_{up} (m/s ²)	a_{down} (m/s ²)	$U(h_1)$ (mJ)	$U(h_2)$ (mJ)

Use these numbers, along with $M = 0.75$ kg, to calculate the friction force on the cart. Compare it with the value you obtained from the potential energy difference between the turning points h_1 and h_2 .

- b) Explain briefly in words why it makes sense to fit the function $A \sin[2\pi(x-C)/T]$ to the force peaks when the cart bounces off the spring on the force sensor.

- c) Enter the results of your fit to the second bounce into this table:

A (N)	k (N/m)	$A^2/2k$ (mJ)

and use them to find the force constant of the spring. Compute the potential energy stored in the compressed spring, $A^2/2k$, and compare it with the average of $U(h_1)$ and $U(h_2)$ from the table above.

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a) Enter the values from your experiment into the table below.

Quantity:	a_{up} (m/s ²)	a_{down} (m/s ²)	$U(x_1)$ (mJ)	$U(x_2)$ (mJ)
My value:	0.390 ± 0.008 m/s ²	0.330 ± 0.005 m/s ²	61.9 mJ	51.8 mJ

Answer: any sensible numbers are fine.

Use these numbers, along with $M = 0.75$ kg, to calculate the friction force on the cart. Compare it with the value you obtained from the potential energy difference between the turning points x_1 and x_2 .

Answer: from the free body diagrams, it is clear that $F_{\text{friction}} = M(a_{\text{up}} - a_{\text{down}})/2 = 22.5$ mN. Between x_1 and x_2 cart travelled 0.45 m, and $U(x_1) - U(x_2) = 10.1$ mJ. Thus $F_{\text{friction}} = 10.1/0.45 = 22.4$ mN.

b) Explain briefly in words why it makes sense to fit the function $A \sin[2\pi(x - C)/T]$ to the force peaks when the cart bounces off the spring on the force sensor.

Answer: anything that captures the idea that it is $\frac{1}{2}$ of a harmonic oscillator is OK.

c) Enter the results of your fit to the second bounce into this table

Quantity:	A (N)	T (s)	k (N/m)	$A^2/2k$ (mJ)
My values:	15.3 ± 0.12 N	0.130 ± 0.001 s		

and use them to find the force constant of the spring.

Answer: $\omega = 2\pi/T = \sqrt{k/m}$, thus $k = 4\pi^2 m/T^2 = 1750$ N.

Compute the potential energy stored in the compressed spring, $A^2/2k$, and compare it with the average of $U(x_1)$ and $U(x_2)$ from the table above.

Answer: $U = \frac{1}{2} k x_{\text{max}}^2 = A^2/2k = 66.8$ mJ, while $[U(x_1) \text{ and } U(x_2)]/2 = 59.8$ mJ. Should be closer, but that's what I got.