Period Synchronization of Harmonic Motions

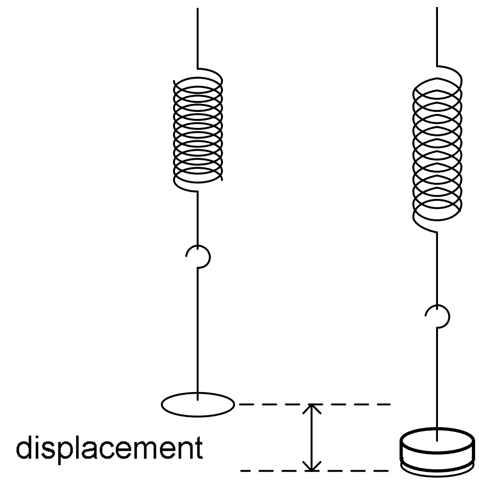
Name________________________________ ID________________________ TA________________

Partners____

Date______________________________________ Section____________________________________

Please exercise caution so that the swinging weight does not hit people and the photo gate, and treat all springs gently.

The purpose of this experiment is to find that the periods of pendulum and spring motions can be determined by measuring the displacement of spring with a hanging mass. If the displacement is equal to the length of the pendulum string, the period of the both cases can be equal.



Procedure:
① Record the reading at the bottom of the hanger with a meter stick without any extra mass.
② Put the mass on the hanger, and read the meter stick at the bottom of the hanger.
③ Calculate the displacement and the spring constant.

1. Finding the displacement of the spring (*Use meters, kilograms, and newtons for the units.*)

TABLE 1-1

Hanging mass, m, without considering mass of the hanger	The reading at the bottom of the mass hanger, h_0	The reading at the bottom of the hanger after adding the designated mass, h	Displacement $x = h - h_0$ (These will be used in experiment 3.)	Spring constant $k = mg/x$
0.200 kg			(I.200)	
0.250 kg			(I.250)	
0.300 kg			(I.300)	
0.350 kg			(I.350)	
0.400 kg			(I.400)	

Calculate the average of the spring constant. k = ____________________ (N/m)

2. Period of the spring motion

The Fig. 1 depicts the initial point of spring motion. The equilibrium point should be set at the level of photo gate. Fig. 2 illustrates how to align the mass hanger. In Fig. 2.b, the other part of the hanger could be caught by the photo gate and may give a wrong result.

Procedure:
① After setting up as shown in Fig. 1, lift the mass hanger by about a couple of inches and release it.
② Then, measure the period of the spring oscillation with the photo gate.

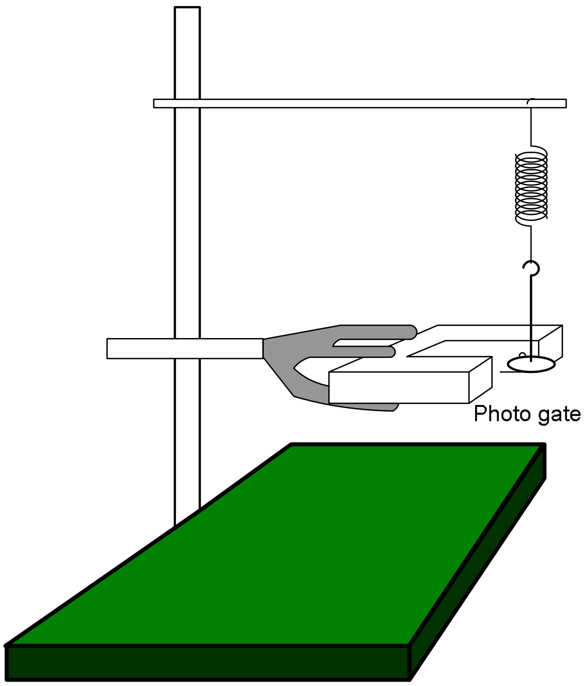


Fig. 1

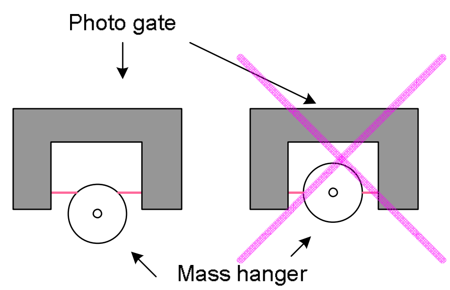


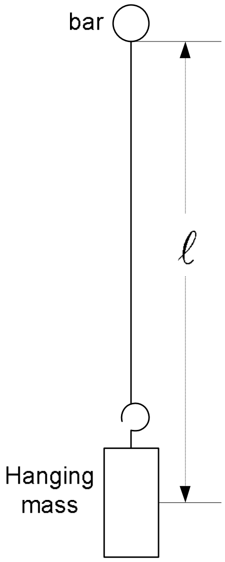
Fig. 2.a Fig. 2.b

The Bottom View

TABLE 2-1

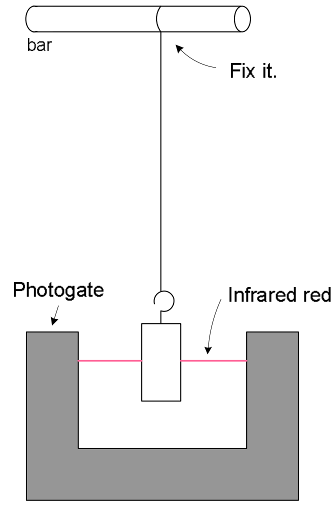
Hanging mass, m, <u>including</u> the mass hanger	Period of the spring motion (Theoretical) $T = 2\pi\sqrt{m/k}$ [Use the average k.]	Period of the spring motion (Experimental)
0.200 kg		(S.1)
0.250 kg		(S.2)
0.300 kg		(S.3)
0.350 kg		(S.4)
0.400 kg		(S.5)

3. Period of the pendulum motion

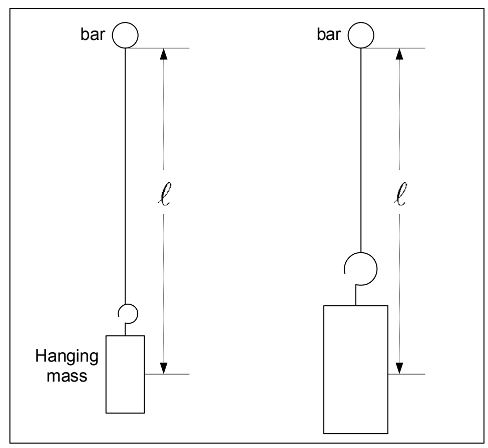


⇐ The length, ℓ, should be taken from the bottom of the bar to middle of the hanging mass.

Before swinging, make sure that the infrared red is placed middle of the hanging mass. (The light is invisible, but you can see where it comes from.) ⇒



The length can be changed with the size of hanging masses as shown. Make sure the length for each case. ⇒



Swing it with small angle (such as less than 10 degrees).

TABLE 3-1

Hanging mass, m	Length (ℓ) This is equal to the displacement in the experiment 1.	Period of the pendulum motion (Theoretical) $T = 2\pi\sqrt{\ell/g}$	Period of the pendulum motion (Experimental)
	(from I.200)		(P.1)
	(from I.250)		(P.2)
	(from I.300)		(P.3)
	(from I.350)		(P.4)
	(from I.400)		(P.5)

4. Period synchronization

From TABLE 2-1 and TABLE 3-1, copy the calculated periods, $T_S = 2\pi\sqrt{m/k}$ and $T_S = 2\pi\sqrt{\ell/g}$. Make sure if these are almost identical.

TABLE 4-1

Period of the spring motion (Theoretical) [Copy from TABLE 2-1.] $T_S = 2\pi\sqrt{m/k}$	Period of the pendulum motion (Theoretical) [Copy from TABLE 3-1.] $T_S = 2\pi\sqrt{\ell/g}$

Compare each experimental result from TABLE 2-1 and TABLE 3-1, such as between S.1 and P.1.

TABLE 4-2

Period of the spring motion (Experimental) [Copy from TABLE 2-1.] T_S^{EXP}	Period of the pendulum motion (Experimental) [Copy from TABLE 3-1.] T_P^{EXP}	Percent difference $\dfrac{T_S^{EXP} - T_P^{EXP}}{\left(\frac{T_S^{EXP} + T_P^{EXP}}{2}\right)}$

Do you obtain an equal period between the spring and pendulum motions by using the equal displacement of the spring and the length of the pendulum?