

Variable G Pendulum

Purpose

1. Period of single pendulum.
2. Decrease the influence of pendulum period g.
3. Large amplitude period.

Theory

The period of pendulum changes with the length of pendulum. Theoretically, the weight of pendulum and the amplitude are irrelevant to the swinging period. The equation can be expressed as:

$$T = 2\pi \sqrt{\frac{L}{g}} \quad (1)$$

T : Period. The time it takes for pendulum to complete one swing.

L : Pendulum length

g : Acceleration of gravity, about $g = 9.8 \text{ m/s}^2$.

π : Ratio of the circumference of a circle to its diameter, about 3.14159.....

The plane rotation angle of the single pendulum is ψ . During its motion, the pendulum is still influenced by the pulling gravity. The gravity on the plane is $mg\cos\phi$. However, both single pendulum swings with elevation angle and in plumbing line are influenced by same factors so the period of pendulum can be expressed as

$$T = 2\pi \sqrt{\frac{L}{g \cos \phi}} \quad (2)$$



However, the ideal condition is the moment of inertia $I = mL^2$ ◦

$$I = M\left(\frac{R_1^2 + R_2^2 + R_1 R_2}{3} + \frac{a^2}{4}\right) + \frac{1}{3}mL^2 \quad (3)$$

The pendulum weights M and the rod weights m . The distance the fulcrum to the upper part of pendulum is R_1 and the distance from fulcrum to the lower part of pendulum is R_2 . The length of rod is L and the radius of cylindrical surface of pendulum is a .



Instruments

No	Accessory	Qty	No.	Accessory	Qty
1	Base	1	2	Support rod	1
3	Angle disk	1	4	Set of support rod	1
5	Pendulum	1	6	Photogate (A)	
				Additional selection	
7	Photogate electronic timer				
	Additional selection				





Procedure

1. The experimental setup is shown in above figures. If photogate electronic timer is not included, please prepare your timer to keep records on the experiment recording sheet.
2. Set up the photogate electronic timer: Function 4. When ch1 photogate detects the shield of light, the timer starts recording. The timer can record 10 sets of data maximum.
3. Press “reset” to restart recording.
4. Measure periods of five angles accordingly. Compare measured periods and the calculated periods.
5. Use data on the experiment recording sheet to draw the relationship between pendulum and angles.
6. Discuss the decrease of period of pendulum g .



Experiment recording sheet

Weight of pendulum M	
Weight of rod m	
Distance from the fulcrum to the upper part of pendulum R ₁	
Distance from the fulcrum to the lower part of pendulum R ₂	
Length of rod L	
Radius of the cylindrical surface of pendulum a	

Plane rotation angle		0°				
Trail						
Period measurement	1					
	2					
	3					
	4					
	5					
	6					
	7					
	8					
	9					
	10					
Average period						
Period calculation						
$T = 2\pi \sqrt{\frac{L}{g \cos \phi}}$						
Error of period %						
Ideal calculated period						
(According to equation (3), adjust the period)						
Error of ideal period %						



Questions and discussion

1. According to the experiment recording sheet, record the large amplitude period. What will happen if the angle is smaller than 5 degrees? Discuss it with the experiment.



Atis Scientific Instruments Co.,Ltd
Address : 1F., No.18, Nanming St., South Dist.,
Tainan City 702, Taiwan (R.O.C.)

E-mail:atis@atissi.com.tw
Tel: (886) -6-2925201
Fax: (886)-6- 2611476
Mobile:+886-9-8006-1128
Website: www.atis.com.tw

All rights reserved