A01-424P-Y01

Heavy ball Centrifugal force experiment

- **Experiment purpose**

During spinning experiment, the relation of movement circular angular velocity and movement opening angle are on the spherical pendulum.

Image 2-1 Metal ball is flying because of centrifugal force.

- **Experiment theory**

A mass m(kg) is in this experiment. The rotation speed in the vertical axis is **ω**(rad/s) and bring heavy ball to do circular motion with radius r(m). The tangential velocity is v(m/s). At that time there are horizontal centrifugal force F'_c (N), the gravity and the tensile force T(N) of the arm length L(m). To combine these forces will result in an included angle from heavy ball and the vertical axis that we call opening angle θ. As below image (1).

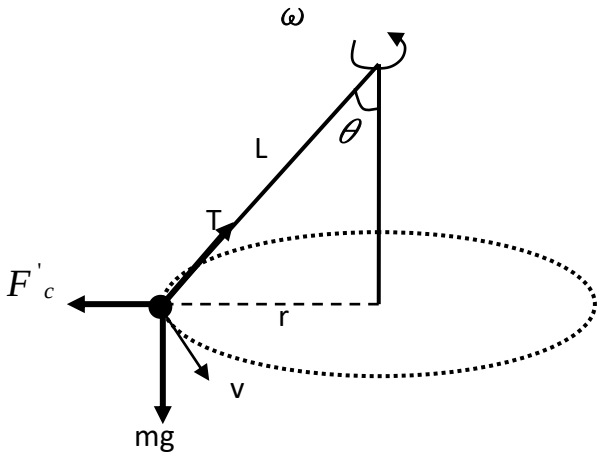


Image (1)

From the image we get a relation formula of horizontal tensile force and centrifugal force.

$$TSin\theta = F'_c = ma'_c \tag{1}$$

The centrifugal acceleration is

$$a'_c = \frac{v^2}{r} = \omega^2 r \tag{2}$$

We bring formula (2) to formula (1) and get,

$$Tsin\ \theta = m\omega^2 r \tag{3}$$

The formula of the radius of circular motion and the length of arm are,

$$r = Lsin\ \theta \tag{4}$$

The formula of vertical tensile force and the gravity is,

$$Tcos\ \theta = mg \tag{5}$$

We bring formula (4) to formula (3) and combine formula (5) and then we get the opening angle formula:

$$\theta = \cos^{-1}(\frac{g}{\omega^2 L}) \tag{6}$$

- **Experiment accessory**

Experiment device list					
No.	**Name**	**Qty**	**No.**	**Name**	**Qty.**
1	Aluminum alloy multifunction base (with two feet, a precision bearing base)	1	2	two-point adjustable feet	2
3	DC motor	2	4	Rotational speed controller	1
5	DC power supply(12VDC/1A)	1	6	Level meter	1
7	Drive belt	1	8	RCA connecting wire	1
9	Disk with 60 grilles	1	10	heavy ball opening angle rack	1

- **Experiment describes.**

This device uses electric slewing bearing to combine with two plies stepped wheel. By using O shape belt drives two plies bearing base in the center base to provide the needed rotational speed for this experiment. The controller can adjust rotational speed in the electric slewing bearing. Installation image (2), when installing heavy ball opening angle tripod, the fixed wing locked face is a section to the bearing on the disc. Image (3).

Image (2) installation controller

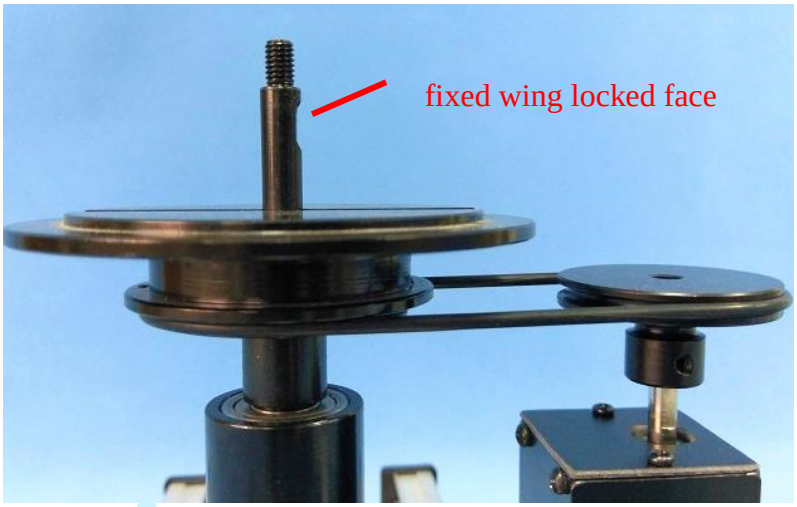
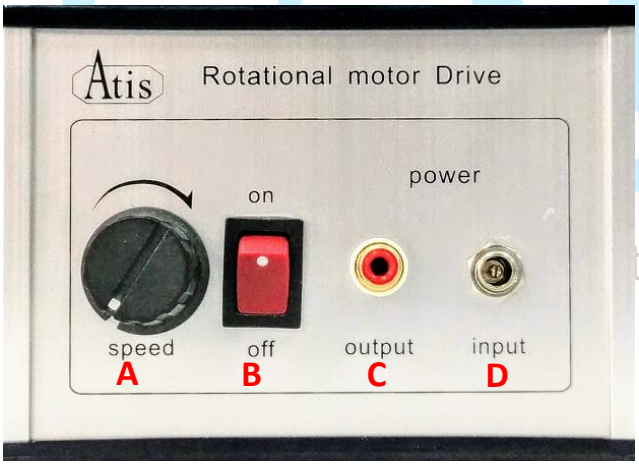


Image (3) Belt drives disc and electric motor

Rotational speed controller instruction:

Instruction with photos

3. one adjust speed controller
4. one power supply:
input:110~220V/50~60Hz；
output:12VDC/1A。
5. one RCA connecting wire



Rotational motor drive instruction：

A. Adjust speed knob, clockwise speed up and counterclockwise slow down.
B. Power switch
C. RCA plug, to connect electric slewing bearing.
D. Power plug, input:12VDC/1A

1. The basic installation Image (4)

Image (4) Device installation image

2. We install the heavy ball opening angle tripod. There is screw hole in the vertical axis base to match groove and install all the way down as image (3). Then we luck it up.
3. We start speed controller and operate electric slewing bearing about 2~5 minutes to check if it is working well or the center rod is leaning. Otherwise, we turn off the machine and adjust.
4. When different rotational speed, we observe the opening angle of the flying ball.
5. Discuss the relation of rotational speed and opening angle.
6. According to the theory, at the same rotational speed we measure the opening angle and inverse calculation rotational speed to get centrifugal acceleration.

- **Experimental data and analysis**

Experiment data recording			
Gravitational acceleration g = _____(m/s^2) Length of pendulum L = _____(m)			
Recording opening angle θ	**Axis rotation speed ω**	**Circumference radius r**	**Centrifugal acceleration** a'_c

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