A01-534S-Y02

Circular motion comprehensive experimental group

I. Experiment item

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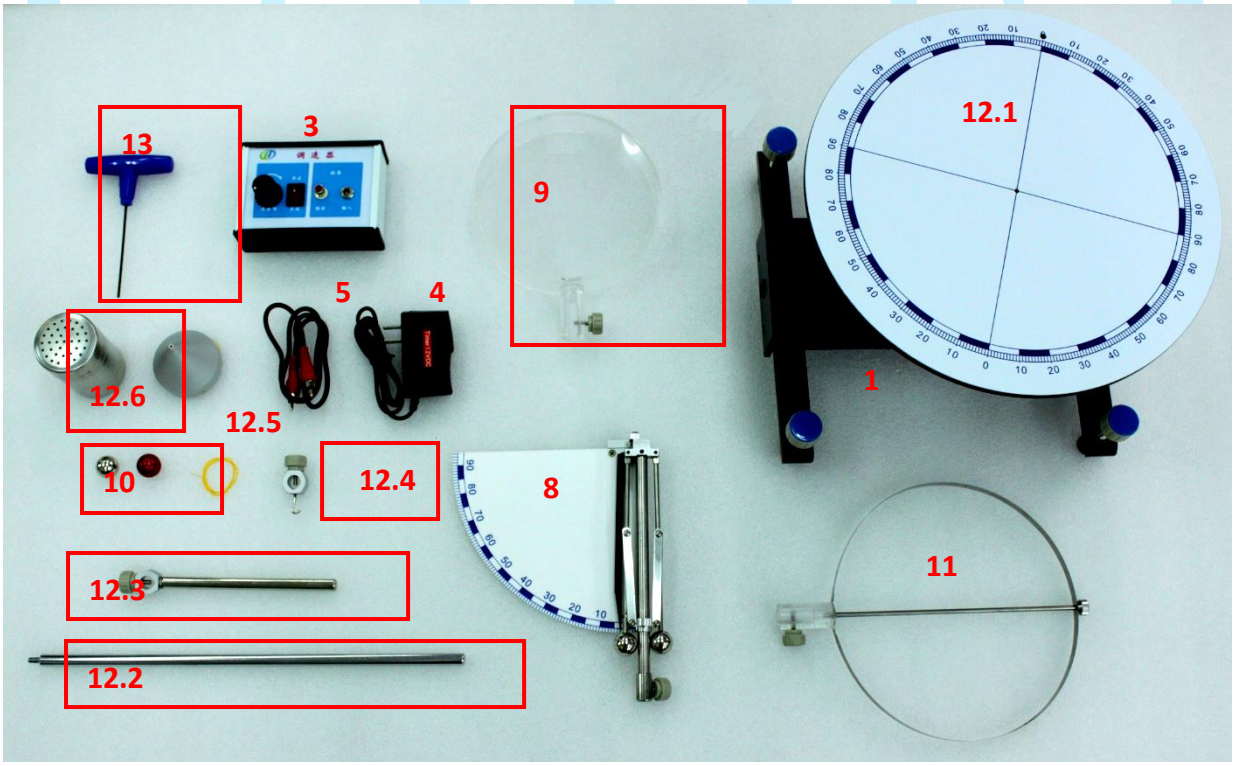
- **Experimental accessory：(For reference only, subject to the actual sample.)**

List of experiment device					
No.	**Name**	**Qty.**	**No.**	**Name**	**Qty.**
1	Multifunction aluminum alloy base (with two feet and bearing base)	1	2	moveable electric rotary machine	2
3	velocity modulation controller	1	4	power supply (12VDC/1A)	1
5	RCA connector	1	6	drive belt	1
7	balance meter	1	8	ball velocity modulation centrifuge frame	1
9	rotational circle tank	1	10	ball (different color)	2
11	compression of the earth ring	1	12	Foucault pendulum experiment set (item 12.1~12.5)	
12.1	scale circle disc with plug	1	12.2	metal rod (with screw ψ10mm×H300mm)	1
12.3	connector rack	1	12.4	hanger with connector	1
12.5	funnel with string	1	12.6	Sand	1
13	工具 tool	1			



2-1 Experiment accessory

Instruction 1. Centrifugal force regulator

This device is combining to electric rotary bearing and two layers stepped wheel and drive the two stepped wheel of the bearing in the center of the base by O shape belt to provide in needs of rotational speed. The rotational speed in electric rotary machine can control the speed by the regulator. Installation as Image 1-1.

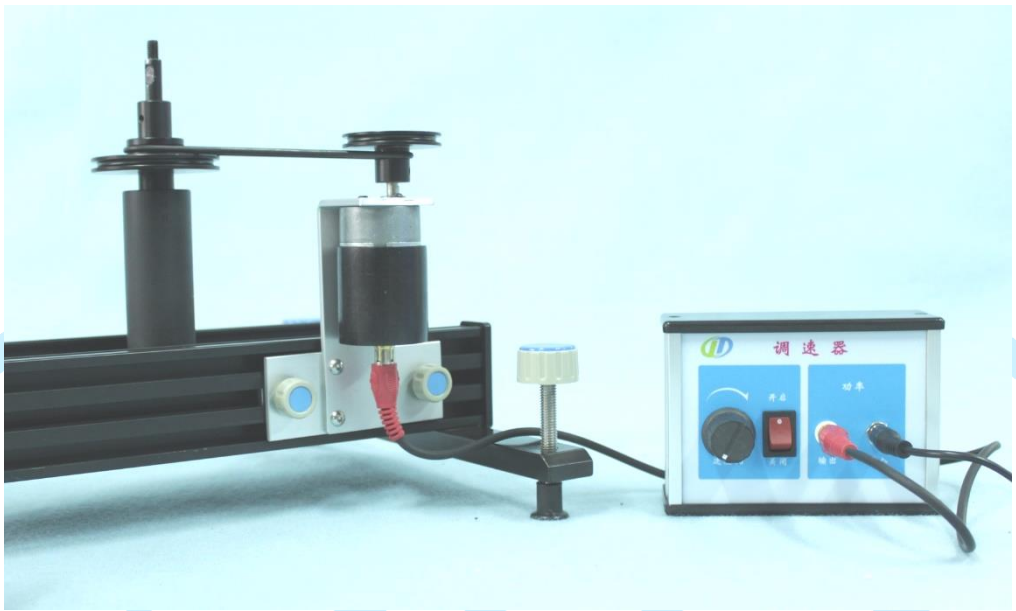


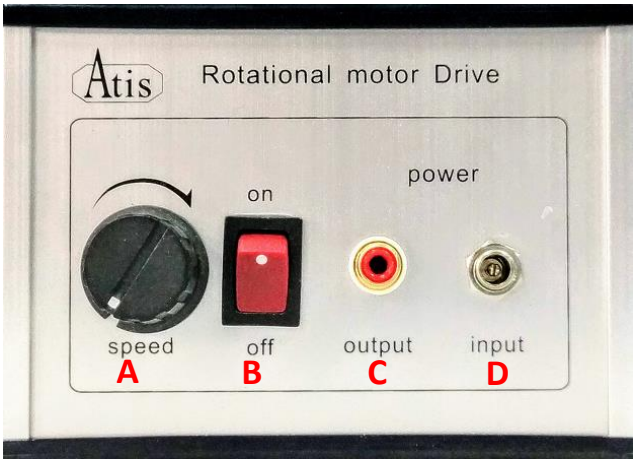
Image 1-1 installs the regulator.

Instruction of accessory:

Accessory image:

Accessory：

3. Adjustable rotational speed controller
4. Power supply × 1：
input:110~220V/50~60Hz；
output:12VDC/1A。
5.RCA connector plug × 1



Regulator instruction：

A. Adjustable speed knob that clockwise is speed up and counterclockwise is speed down.

B. Power switch

C. RCA plug, connect electric rotary machine.

D. Power plug, input:12VDC/1A。

Connecting to regulator and electric rotary machine.

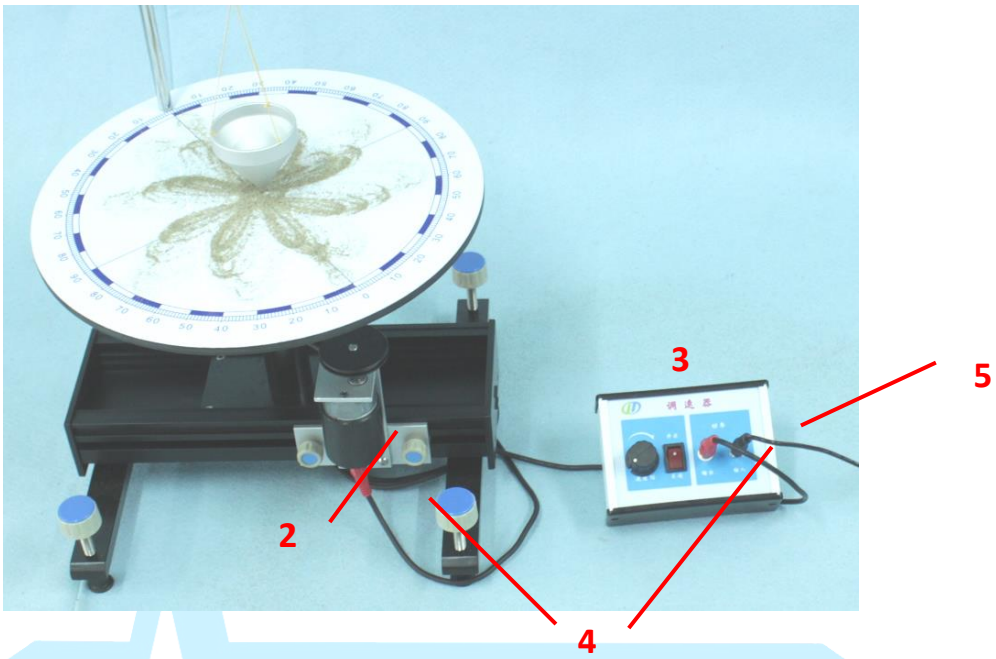


Image 1-1.a Installation image

The normal rational speed range is as below image 2-2 for using about 22~390rpm rotational speed.

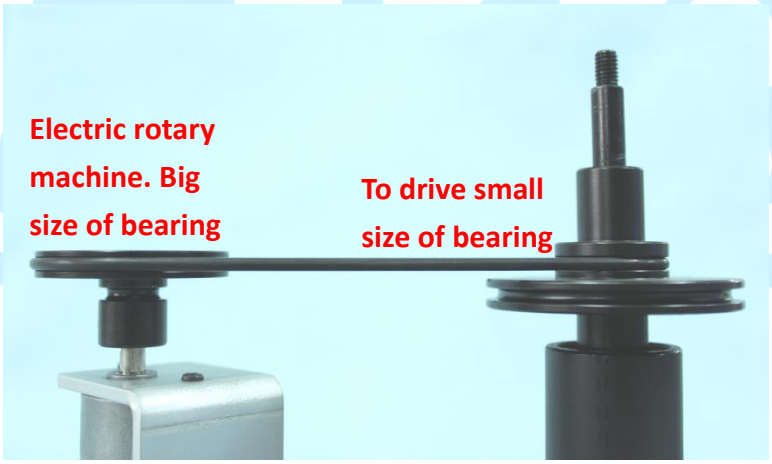


Image 2-2 fast spin illustration

If we need slow spin as experiment 6 Foucault pendulum, according to image 2-3 we change the ratio of the wheel on the belt to use about 5~60rpm.

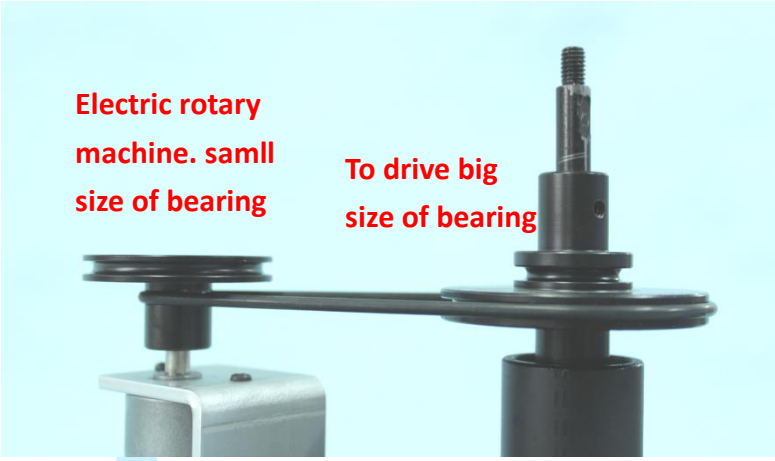


Image 2-3 slow spin illustration

Note:

1. The tight of the belt will affect the rotational speed when beginning to start. We can change the moveable connector in proper and adjust the belt. Don't pull the belt too tight.

2. During this experiment, we avoid hitting any other objects around us and do not force to stop or slow when the machine is working.

Experiment 2. demonstrate centrifugal force.

During this experiment, the angular velocity in circular motion of the pendulum ball is related to opening angle in the motion.

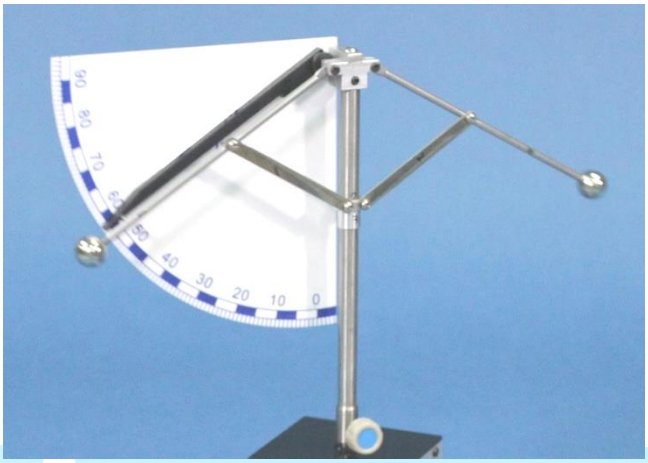


Image 2-1 ball is flying because of centrifugal force

- **Experiment theory**

There is a heavy ball object with mass m(kg) and the rotational velocity in vertical axis is **ω**(rad/s). Thereby, it brings the heavy ball to do circular motion with radius r(m) and the tangential velocity is v(m/s). At this moment, the horizontal centrifugal force F'_c (N), the gravity force and the arm length L(m) of the tension force T(N) are resulting in creating an angle between the heavy ball and vertical axis that we call opening angle θ as image (1-1) shown,

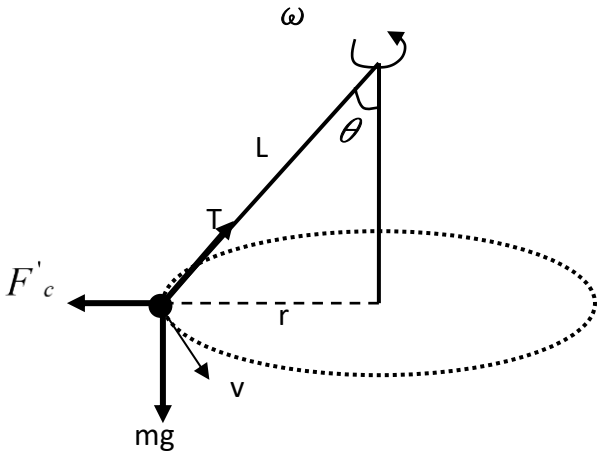


Image (1-1)

From the image we get the related formula between of the horizontal tension 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 relation of the radius of circular motion and the arm length is,

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

the formula of the vertical tensile force and gravity force is:

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

We bring formula (4) to formula (3) and combine to formula (5) that we can get an opening angle related formula:

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

- **Experiment accessory**

List of experiment					
No.	**Name**	**Qty.**	**No.**	**Name**	**Qty.**
1	multifunction aluminum alloy base (with two feet and one bearing)	1	2	moveable electric rotary machine	2
3	adjustable rotational speed controller	1	4	Power supply (12VDC/1A)	1
5	RCA connector wire	1	6	Drive belt	1
7	Level meter	1	8	Flying ball speed control centrifugal force frame	1

- **Experiment instruction**

1. Refer to experiment 1 regulator for centrifugal force on instruction 1-1 for installation.
2. Install a heavy ball on the vertical axis opening angle frame with screw in the bottom and match to the groove to push all the way down and lock up the screw.
3. Start the rotational speed regulator about 2~5 minutes to see if the machine works well or if the center column has inclination. Otherwise, we turn off the machine and adjust.
4. We observe the opening angle of the flying ball with different speed.
5. Discuss about the relation of speed and opening angle.
6. According to the theory, in a constant speed to measure an opening angle and inversely calculate rotational speed to get centrifugal acceleration.

- **Experiment date and analysis**

Experiment data and record			
Gravitational acceleration **g** = _____(m/s^2) Length of pendulum **L** = _____**(m)**			
Record Opening angle θ	**Axis rotational speed ω**	**Circular radius r**	**centrifugal acceleration** a'_c

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