4. Experimental Objectives

1) Observe magnetic damping phenomenon, and understand the concept and applications of magnetic damping
2) Observe sliding friction phenomena, and understand the application of friction coefficient in industry
3) Learn how to process data to transfer a nonlinear equation into a linear equation
4) Acquire magnetic damping coefficient and kinetic friction coefficient

5. Precautions

1) The magnetic field of the slider contacting the rail surface is N pole, the timing sensor can be triggered. If the opposite surface of the slider contacts the rail surface, the magnetism is S pole, the timing sensor cannot be triggered.
2) The magnitude of the magnetic damping coefficient is related to the magnetic induction intensity on the surface of the slider and the impedance of the rail. The sliding friction coefficient is related to the contact situations between the surface of the rail and the surface of the sliding block. Because the magnetic induction intensity of the slider is different or slightly changed for each apparatus, the measured data is slightly different from the example data provided in this manual.

6. Experimental Procedures

1) Adjust the horizontal adjustment screw so that when the magnetic slider slides down from the inclined rail, the slider can keep sliding straight without touching the side of the rail.
2) Slide the magnetic slider and the ordinary non-magnetic slider from the inclined rail respectively, and change the inclination angle of the rail, and observe the magnetic damping phenomenon and dynamic friction phenomenon of the two different sliders.
3) Observe the timing of the smart timer when the magnetic slider slides down the inclined rail. The timer can only be triggered when the N pole is facing the Hall switch.
4) Adjust the inclined rail to a certain inclination angle, and slide the magnetic slider with N pole downward from 5 different heights of the inclined rail. Observe the time t of the magnetic slider passing through the two points of A and B to verify whether the slider moves at a uniform speed.
5) Change the inclination angle of the inclined rail and repeat the above experiment to verify the range of inclination angle of the inclined rail and the magnetic slider can move at a uniform speed. Measure data for the relationship between the sliding speed v of the magnetic slider and the inclination angle θ and record data in a table.
6) Plot $\tan\theta$ -- $v/\cos\theta$ graph, fit as a straight line, and obtain the values of K/W and μ from the slope and intercept of the line.

7. An example of data recording and processing

Note: Following data are for reference only, not the criteria for apparatus performance:

ab=0.500 m   ac=0.500 m

Table 1 Experimental data when the magnetic slider slides from the inclined rail at different inclination angles and different heights.

bc (m)	**θ (°)**	t (S)	cos**θ**	*v* (m/s)	v/cos**θ (m/s)**	tan**θ**
0.7420	42.10	1.919	0.7420	0.1359	0.1832	0.9036
0.7000	45.57	1.770	0.7000	0.1469	0.2099	1．0201
0.6640	48.39	1.665	0.6640	0.1568	0.2361	1.1260
0.6330	50.73	1.578	0.6330	0.1648	0.2603	1.2231
0.5970	53.34	1.496	0.5970	0.1738	0.2911	1.3436

In Table 1, *t* is the reading of the timer.

From the experimental results, within a certain range of inclination angle θ, the movement time *t* of the slider between *A* and *B* is consistent within the error range, so they can all be considered to be uniform.

Table 2 shows the calculation and processing results of the data in Table 1.

Inclination Angle		slider slides down from different heights through the two points A and B t (S)				
bc (m)	θ (°)	C_1	C_2	C_3	C_4	C_5
0.7420	42.10	1.918	1.920	1.913	1.917	1.925
0.7000	45.57	1.776	1.765	1.771	1.773	1.767
0.6640	48.39	1.665	1.654	1.651	1.659	1.662
0.6330	50.73	1.579	1.570	1.572	1.585	1.586
0.5970	53.34	1.493	1.501	1.495	1.498	1.494

The distance between the two points A ans B is AB = 0.2600 m;

The mass of the slider is m = 11.07×10^{-3} Kg

Using least squares method for data calculation, we got:

Slope = 4.067, Intercept = 0.1630, Correlation coefficient r = 0.9996.

Thus the magnetic damping coefficient K and sliding friction coefficient μ are respectively calculated as:

$K = \text{Slope} \cdot W = 4.067 \times 11.07 \times\times 9.794 = 0.4409\ N \cdot s / m$

Or

$K = 0.4409\ Kg /s$

$\mu = \text{intercept} = 0.1630$

From the error transfer formula, the angle calculated using the cosine theorem can only have three significant digits, so we take

$K = 0.441\ N \cdot s / m$; or $K = 0.441\ kg / s$

$\mu = 0.163$