C15-1008-W0　Lever & Pendulum Set
KGF

Instruction Manual

Thank you very much for purchasing Lever & Pendulum set.

Read all these instructions before use.

The Lever & Pendulum set is specialy designed for student experiments in school.

Narika Corporation
2014 Edition

Introduction

This lever & pendulum set is for students' experimentation including a lever unit, a pendulum unit, weights, and a steel stand. For easier experimentation by students, the lever unit has numbered holes on it to hook weights, while the pendulum unit has a semicircular protractor for measuring angle of pendulum, as well as, an adjusting knob to adjust the length of thread. In addition, the lever & pendulum set pays much attention to the storage in schools. Lever unit has a function to be fixed vertically on the steel stand, while pendulum unit has a function to reel a thread of itself, requiring less space for the storage. With the lever unit, students' group may carry out the experimentation for "Motion of Force" such as the correlation between fulcrum point and point of effort/load or moment of force. With the pendulum unit, students' group may carry out experimentation for "Pendulum motion" such as correlation between the length of thread with weight and the cycle, as well as, energy conversion of potential/kinetic energy.

Safety Precautions (read before use)

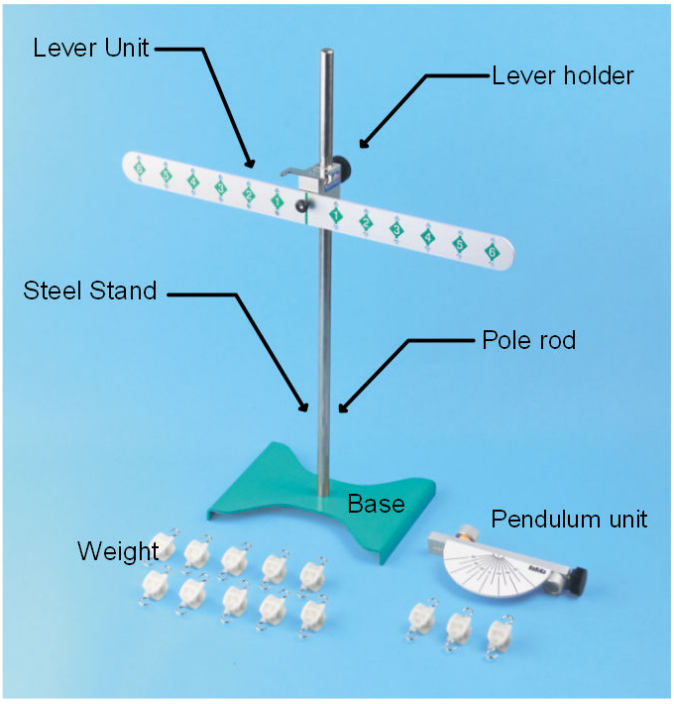
⚠Notice

1. **Make sure knobs on lever unit and pendulum unit (depending on which unit you use) at the pole of stand are securely tightened.**

2. **Fix the base and the pole of stand.**

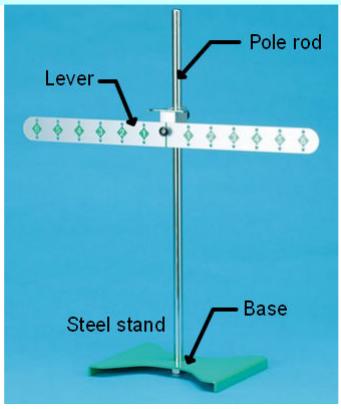
Contents

1. Lever unit	2. Pendulum unit	3. Steel stand	4. Weight
*Arm (Lever): 1	*Protractor: 1	*Pole rod: 1	*13 pcs
*Lever holder: 1	*Thread: 1	*Base: 1	



Specification

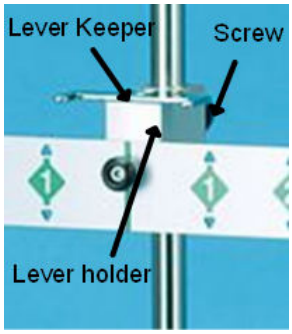
For “Lever Mode” (Lever Apparatus)



1. Pole rod
*Material: Brass and nickel chrome plate,
*Size: ϕ 12×ca 440mm

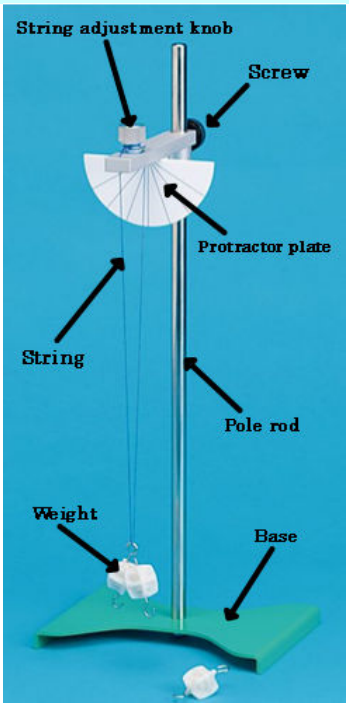
2. Base
*Material: Steel,
*Size: 180×140×15mm,
*Weight: ca 480g

3. Lever
*Material: Aluminum,
*Size: 30 x 400mm,
*12 scale marks (30mm space) with printed numbers 1~6 on both side of the lever.
*12 holes on upper and lower edge of the lever, total 24 holes.



4. Lever holder
*Size:ca55×50×35mm,
*Weight: ca 80g

For “Pendulum Mode” (Pendulum Apparatus)



1. Pole rod
*same as before

2. Base
*same as before

3. Protractor plate
* Diameter 100mm, Semi-circular, Max.120 degrees (10 degrees step)

4. String adjustment knob
*String reeling

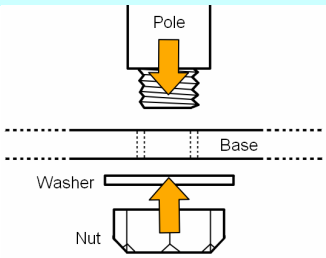
5. Screw
*M4 x 8mm

6. Thread
*To be suspended in V-shape. Length: Max.1m.

Preparation (Assembling)

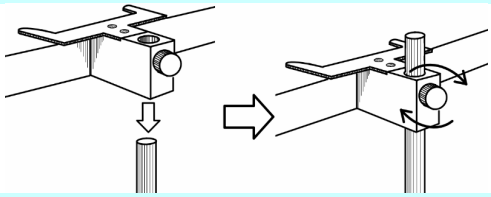
1. Assembling Stand

1. Remove the nut and washer from the pole at once.
2. Install the pole into the hole in the base.
3. Tighten the pole by the washer and the nut using tools.
4. Before experiment, check that the screw is tightened enough.



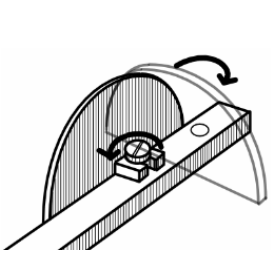
2. Setting up Lever

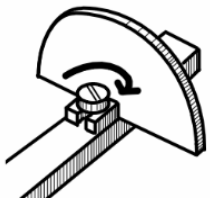
1. Insert the pole rod into lever holder.
2. Tighten the screw of the lever holder.

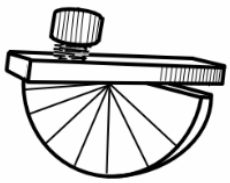


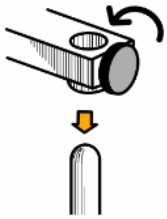
3. Setting up Pendulum

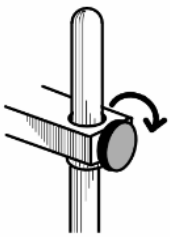
1. Loose its screw and turn the protractor plate of the pendulum unit to be mounted orthogonally on its rod (see step1).
2. Tighten the screw on the rod at the orthogonal position of the protractor plate and the rod (see step2).
3. Protractor plate should be fixed by the screw (see step 3).
4. Loose the screw at the end of the rod and insert the top of pole (see step 4).
5. Tighten the screw at a suitable position (height) for the pendulum experiment (see step 5).


Step 1

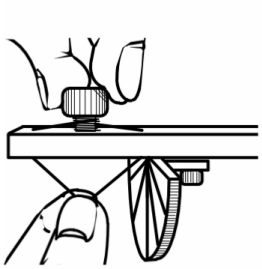

Step 2

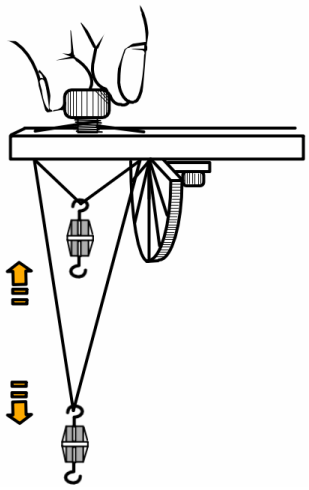

Step 3


Step 4


Step 5

6. Pull out a string while turning the string adjustment knob anticlockwise by your fingers (see step 6).
7. Hook a weight on the string.
8. Adjust the string to suitable length for the experiment by turning the string adjustment knob clockwise or anticlockwise (see step 7).

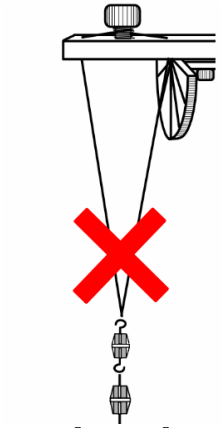

Step 6


Step 7

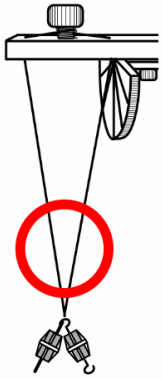
Caution of Pendulum Apparatus during the experiment

1. Position of weights
   If the weights are hooked like in Fig.1, they may cause errors in the experiment. When using several weights in the experiment, hook them like in Fig.2 in order to align the center of weights (see Fig.1 & 2).

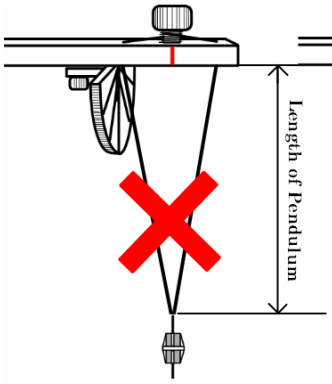
2. Length of Pendulum (thread length)
   Common mistake in measuring the length of pendulum is: measuring the length from the bottom vertex of a triangle, where weight is hooked (V shape) to the bottom surface of the rod (see Fig.3). The correct length of pendulum is from the center of weight to the bottom surface of the rod – red line (see Fig. 4). You should use the vertical line distance in Fig.4 as the correct length of pendulum.



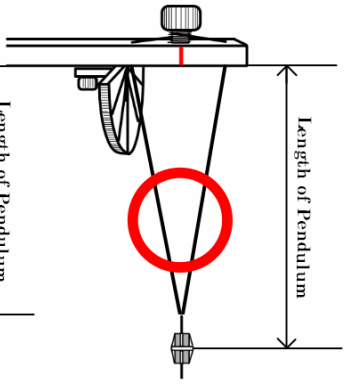
[Fig.1]



[Fig. 2]

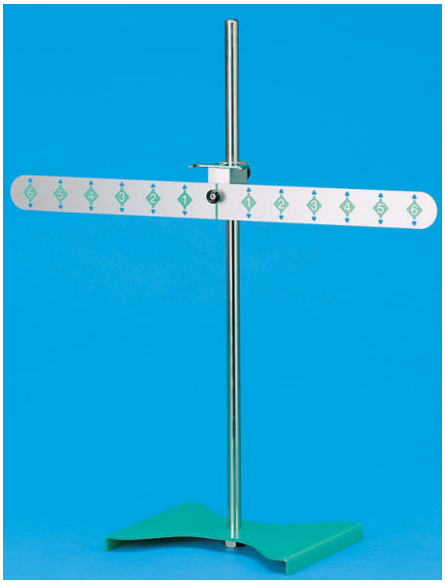


[Fig. 3]



[Fig. 4]

Completed Apparatus



Lever mode

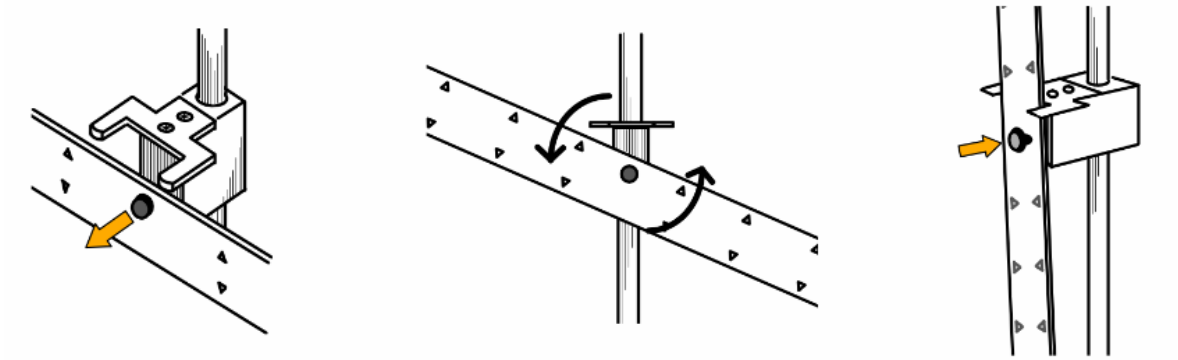
Pendulum mode

Storing Apparatus

Storing Lever Apparatus

The lever apparatus is not suitable for storage, because lever is too long to usually fit into a cabinet of a science room. You can save space and store many lever apparatuses in a cabinet, since the lever apparatus has a storage mode for easier storage.

1. Pull the knob in the center of lever (see step 1).
2. Turn the lever pulling (see step 2).
3. Move the lever to vertical position and push the knob to hold it (see step3).

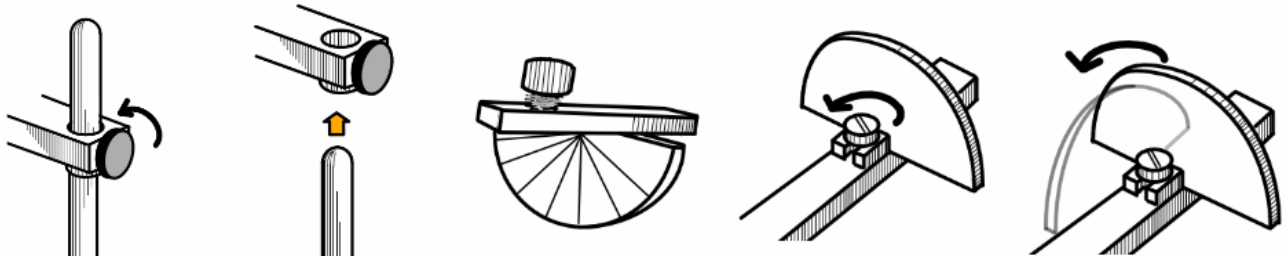


Step 1 Step 2 Step 3

Storing Pendulum Apparatus

The pendulum apparatus (unit) has storage mode such as the lever apparatus.

1. Pull the pendulum unit out from the pole rod (see step 1, 2, 3).
2. Turn the Protractor plate to vertical position (see step 4, 5).

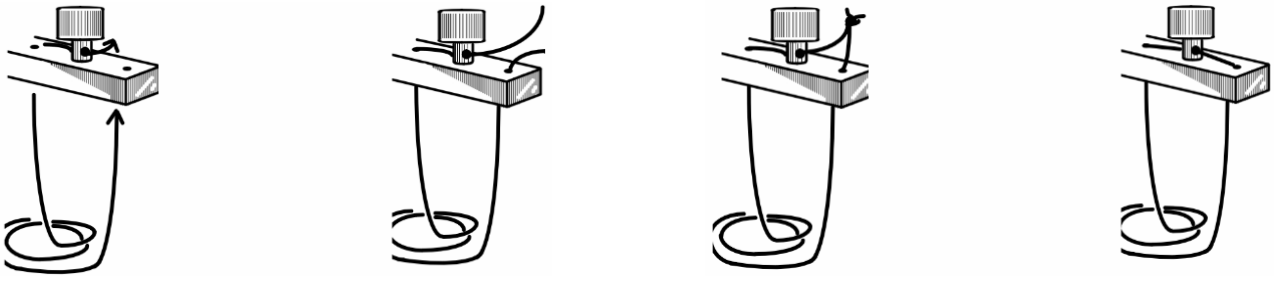


Step 1 Step 2 Step 3 Step 4 Step 5

Maintenance of Pendulum

When you should exchange a thread of pendulum to new one, follow steps below.

1. Remove existing string from the pendulum unit.
2. Insert a new string into 2 holes, one edge on the top of the pendulum unit and the other edge on the string adjustment knob (see step 1 and step 2).
3. Tie both ends of the string (see step 3).
4. Move the tied knot into the hole of the string adjustment knob (see step 4).



Step 1 Step 2 Step 3 Step 4

Sample of Experiment

Experiment 1 (Lever Apparatus)

Lever Apparatus is designed for a student experiments regarding moment (of force) – torque in the lever balance. Moment of force is the product of the distance of mass from the fulcrum point and the weight.

[Weight] x [Distance from the fulcrum point] = Moment of force

Therefore when an anticlockwise moment equals a clockwise moment of the lever, the lever can keep its balance horizontally.

Moment (anticlockwise) = Moment (clockwise)

Let's set weight unit as 1w and set distance unit as 1a.

In Fig.1, the right side of the lever has a weight at position 4. Its moment of force is:

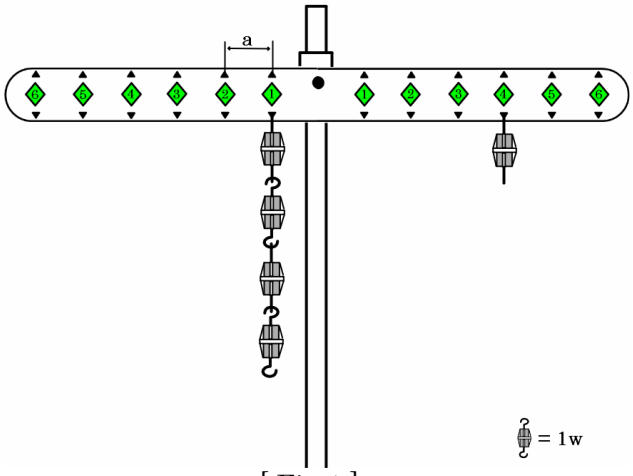
[Moment(clockwise)] = 4a x 1w = 4aw

The left side of the lever has 4 weights at position 1. Its moment is:

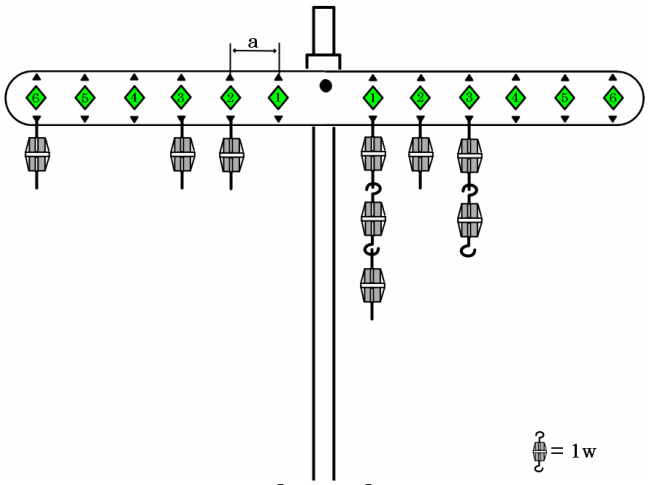
[Moment(anticlockwise)] = 1a x 4w = 4aw.

Therefore:

[Moment (clockwise)] = [Moment (anticlockwise)]



[Fig.1]



[Fig.2]

In Fig.2, the right side of the lever has 3 weights at position 1, 1 weight at position 2, and 2 weights at position 3. Its moment of force is:

[Moment(clockwise)] = (1a x 3w) + (2a x 1w) + (3a x 2w) = 3aw + 2aw + 6aw = 11aw

The left side of the lever has 1 weight at position 2, 1 weight at position 3, and 1 weight at position 6. Its moment of force is:

[Moment(anticlockwise)] = (2a x 1w) + (3a x 1w) + (6a x 1w) = 2aw + 3aw + 6aw = 11aw.

Therefore:

[Moment (clockwise)] =
[Moment (anticlockwise)]

Experiment 2 (Pendulum Apparatus)

The period of the pendulum for student experiment.

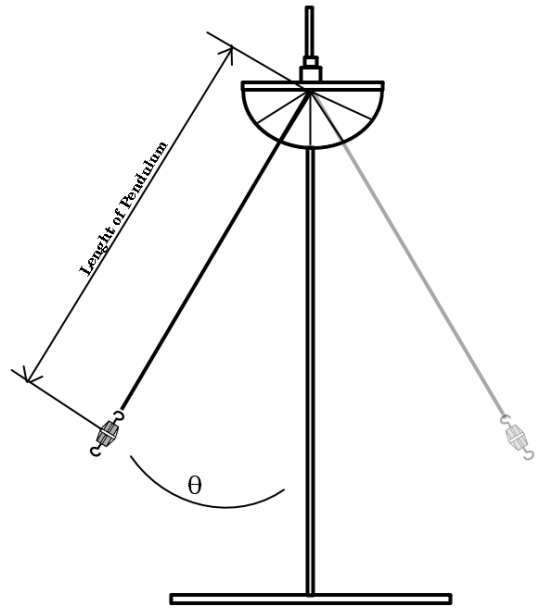
1. Preparation
   Teacher should prepare the pendulum apparatus and a stopwatch, and a ruler for this student experiment.

2. Procedure
   1) Set the thread length of pendulum about 20 cm by using the ruler.
   2) Hook a weight (10g) on the string.
   3) Lift the weight up to the angle of string θ (amplitude) = 8 ~ 10 degrees.
   4) Measure the time by a stopwatch during 10 periods of back and forth motion.
   5) Fill out result on the datasheet.
   6) Change conditions of experiment, such as: add weights, change length of the string pendulum (to 25, 30 cm etc.) and make the experiment again and again to see the different results.

3. Result

Length(cm)	Weight(g)	Total Time(s)	Time/10(s)
1)			
2)			
3)			
4)			
5)			

*"Time/10" is "Total Time" divided by 10 (the amount of periods).



The pendulum's period is shown as below:

$$T = 2\pi\sqrt{\frac{L}{g}}$$

*T is period, L is length of pendulum, g is gravitational acceleration. The equation is for teacher.

Narika Corporation
3-10, Soto-kanda 5-chome, Chiyoda-ku, Tokyo 101-0021
Phone: +81-3-3833-0741, e-mail:global@rika.com
URL http://global.narika.jp