

Instruction manual

C15-2851-W0

High-accuracy Monkey & Hunter Set



July 2022

Safety Precautions

- ⚠ **Do not disassemble, repair, and remodel this product. The warranty will be void.**
- ⚠ **Do not apply electric voltages over 4 V (maximum allowable input voltage) to the ball release unit (hereinafter, BRU). Otherwise, the electromagnetic coil of the unit may ignite and burn out.**
- ⚠ **This product is for a teacher's demonstration only.**
- ⚠ **Keep your students away from this product, especially, from the course of launched ball during demonstration.**
- ⚠ **Should you find any defect in the product, do not repair it by yourself. Contact your distributor.**
- ⚠ **Keep dry. Otherwise, the product can be damaged.**
- ⚠ **Do not use this product on an uneven surface.**
- ⚠ **Avoid direct sunlight and high temperatures.**

Product's Feature

Compared with conventional type of apparatus, this product better demonstrates an essential and classic physics problem, known as “the Monkey and the Hunter”, by providing students with high-accuracy collision of a projectile (an aluminum ball used as a bullet shot by a hunter) with a free-falling object (a plastic ball used as a monkey falling from a tree). Achieved highly accurate and repeatable collision of a small projectile (an aluminum ball of diameter 25mm) with a small free-falling object (a plastic ball of diameter 35mm) over the airline distance of around 1500mm.

Specification

- Size after assembly (excluding a support stand): 1,900 × 570 × 720mm
- Boom: 1,900mm (the full-length rail after two rails is united with each other)
- Ball release unit: Electromagnetic type (Rated voltage: DC 2.5V, Maximum input voltage: 4.0V)
- Ball launcher: Spring plunger type
- Accessories:
 - Free-falling object: φ35mm Plastic ball x2 pcs
 - Projectile: φ25mm Aluminum ball x2 pcs
 - Metallic ring-shaped plumb connected with a magnet via a kite string (1m) x1 pc

Required equipment (not included, prepare beforehand by yourself): a DC power supply (2.5V recommended, max. 4V, 5A), a support stand with a clamp to fix a supporting rod (8mm diameter).

Description of each part

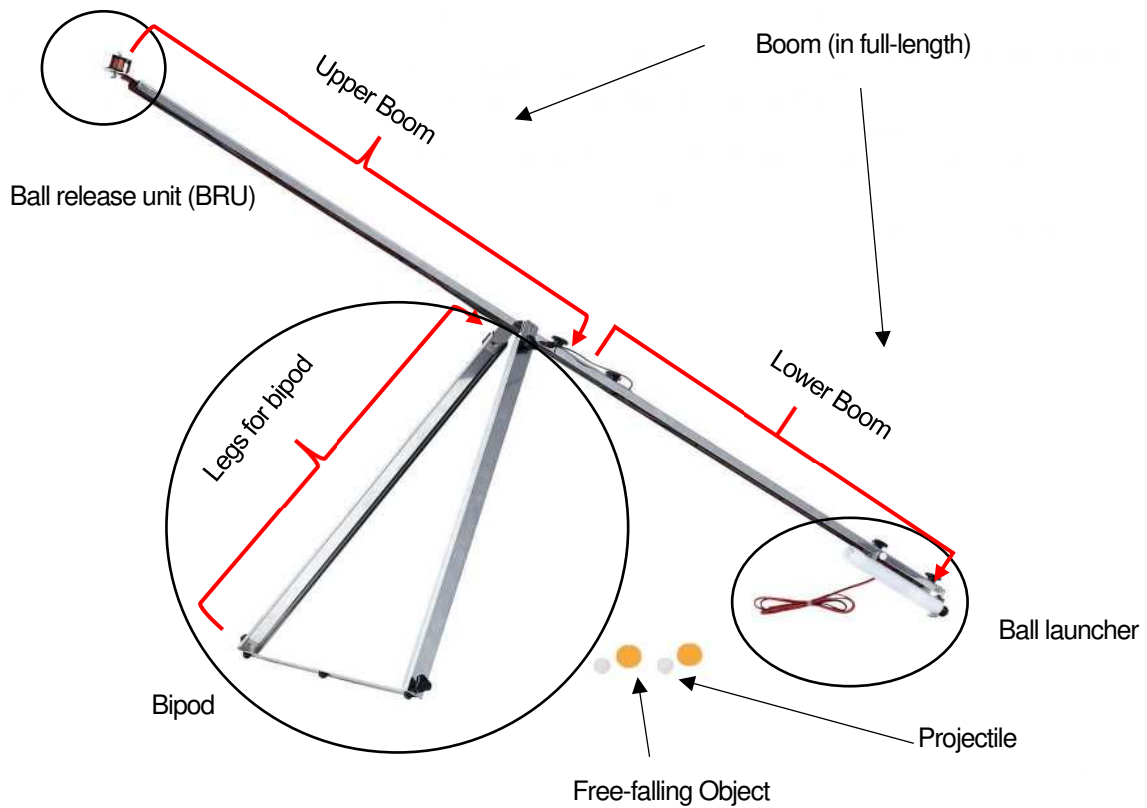


Fig. 1 Assembled apparatus

How to set up

1. Securely unite the upper boom with the lower boom using two of screw with a built-in knob to assemble the full-length boom.

2. Connect each of the built-in lead wires (red and black, one each) of the lower boom, with each of the color terminals located along the sides of the upper boom (red wire with red terminal, black wire with black terminal) to complete assembling the boom (see Fig. 2).

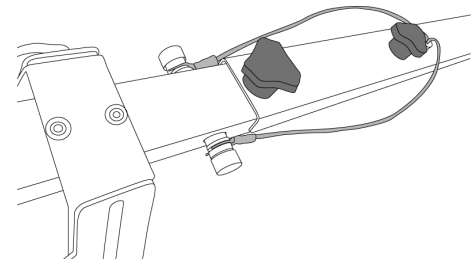


Fig. 2 Wire connection

3. Find the U-shaped bracket mounted on the upper boom. To fix each leg at a proper angle to the upper boom, slide each leg fully into the U-shaped bracket and firmly screw it with two screws with a built-in knob (see Fig. 3). If not attached at first, slide the two legs into the bracket and fix them by the screws.

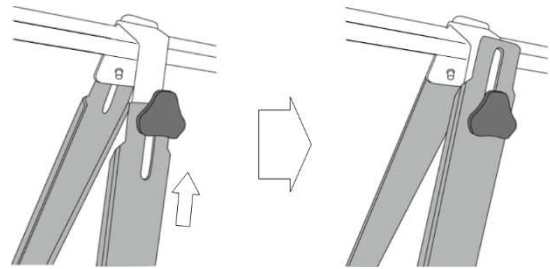


Fig. 3 Assembling the bipod

4. Connect the brace with the other end of each leg using two screws with a built-in knob to stabilize the bipod (see Fig. 4).

5. Use prepared support stand and a clamp. Insert and clamp the supporting rod part of the lower boom into the clamping hole of the support stand. Thanks to this setting, the launching angle of a projectile will be adjustable by changing the height of the clamp part of the support stand and the spring firing pin (SFP) will smoothly work.

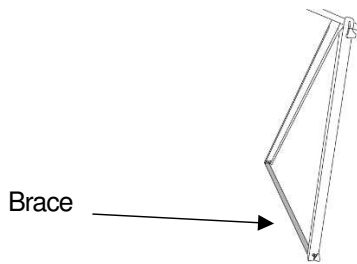


Fig. 4 Bipod

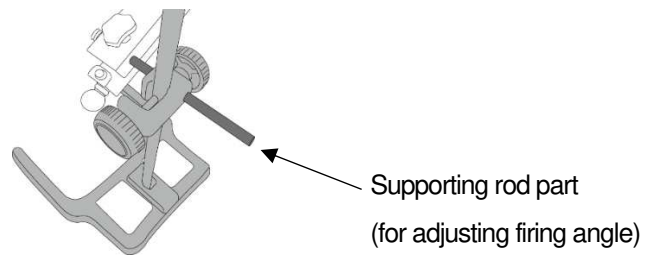


Fig. 5 Support rod with a support stand

How to use “Ball Release Unit (BRU)”:

BRU is equipped with a coil to electromagnetically suspend a “Free-falling Object” from the end of the boom (see Fig. 1). In synchronization with triggering and releasing the spring firing pin, the power supply to the coil will cut off. Thus, BRU will release the object simultaneously.

1. Prepare a DC power supply and make sure it is switched off. Connect the built-in lead wires of Ball launcher (each of the red one and black one) to the DC power supply (see Fig. 6 on the right).

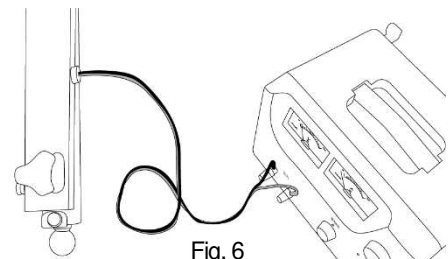


Fig. 6

2. Grasp the knob of SFP, slowly take SFP from the barrel (①), and then, latch SFP at one of its four equally spaced shallow cuts (grooves) (②) to determine the magnitude of launching the ball (see Fig. 8).

3. Set the output voltages of the power supply to DC 3V and stick the free-falling object to the iron core of BRU in such a way that the small steel part of the ball surface directly contacts with the iron core of BRU.

4. Try to detect a threshold voltage value by slowly stepping down the voltage, at which BRU can no longer suspend the

object electromagnetically. The threshold voltage value ought to be between 1.2 to 2.5V.

5. Set the output voltage slightly over the detected threshold so that the object can barely stick to the iron core.

	Do not apply voltage exceeding DC 4V (maximum input voltage) to BRU.
	Do not apply voltage well over the abovementioned threshold voltage value. Otherwise, electromagnetic attraction generated by BRU will be too intense and residual magnetic flux will remain in the coil, due to which BRU will release the free-falling object (plastic ball) delayed than theoretically expected.

How to use “Ball Launcher”:

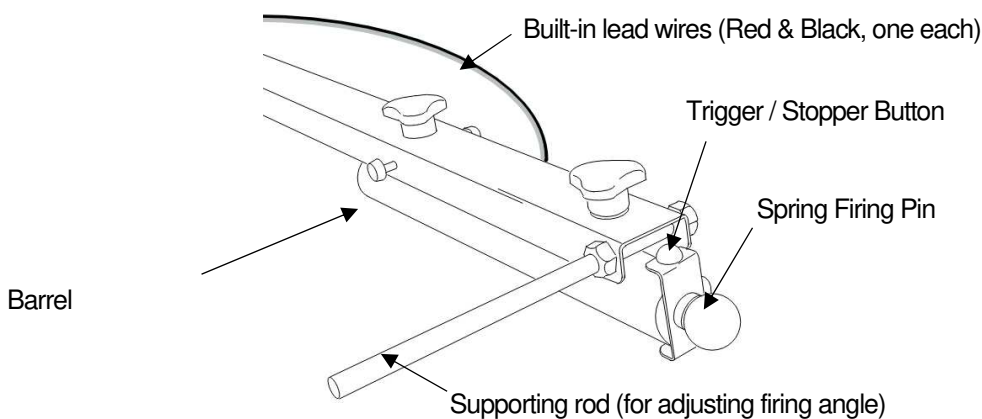


Fig. 7 Ball launcher

Barrel is equipped with an actuator located on the inside of the barrel. In synchronization with triggering and releasing the spring firing pin, designed to cut off a power supply to the coil of Ball Release Unit (BRU) to release a ball.

1. Grasp the knob of a Spring Firing Pin (SFP) , slowly take SFP from the barrel (①), and then, latch SFP at one of its four equally spaced shallow cuts (grooves) (②) to determine the magnitude of launching the ball (see Fig. 8).
2. Attach a “Free-falling Object” beneath BRU in such a way that the small steel part of the ball surface directly contacts with the iron core of BRU.
3. Put a “Projectile” in the barrel.
4. When pressing the trigger button of the ball launcher to release the spring firing pin, synchronously, power supply to the coil of BRU will be cut off. Thus, the “Free-falling Object” will also be released simultaneously (see Fig. 8). As a result, the projectile and the object will collide with each other.

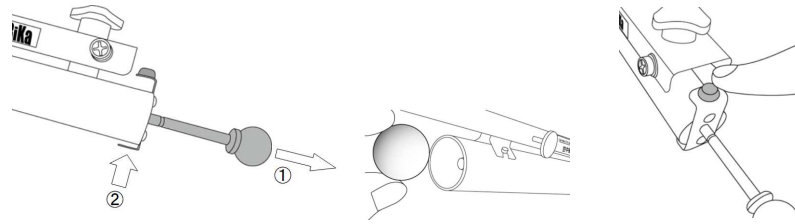


Fig. 8 How to launch (fire) a Projectile

	Do not look into the barrel or aim at something.
	Make sure the area in front of the ball launcher is clear.
	Pressing Trigger/Stopper Button only with index finger is highly recommended. Be careful not to catch finger(s) in between the latch and the knob when SFP gets back.

Specification of “Free-falling Object”

- Diameter 35mm
- Material: ABS resin
- Small steel part on the ball surface: An area for sticking the ball to the iron core of BRU.

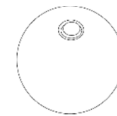
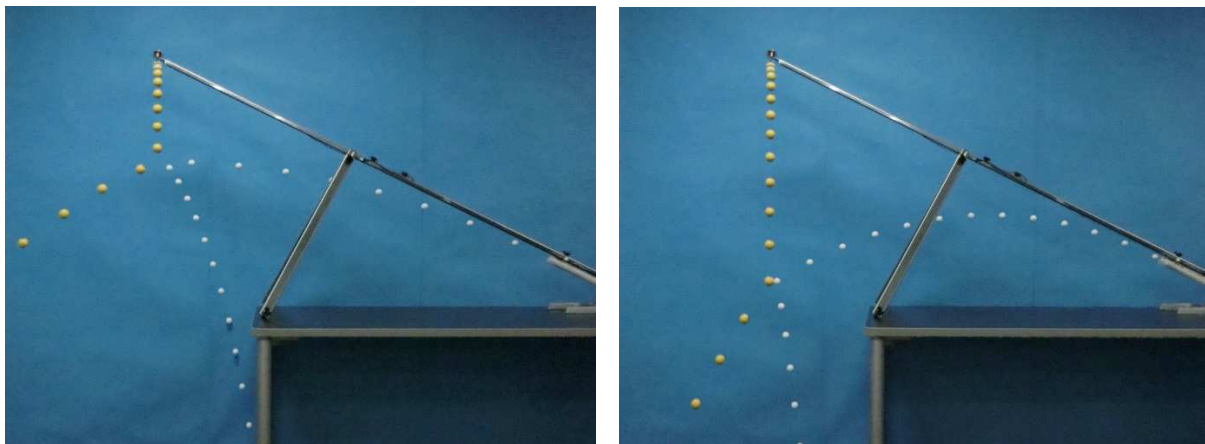


Fig. 9

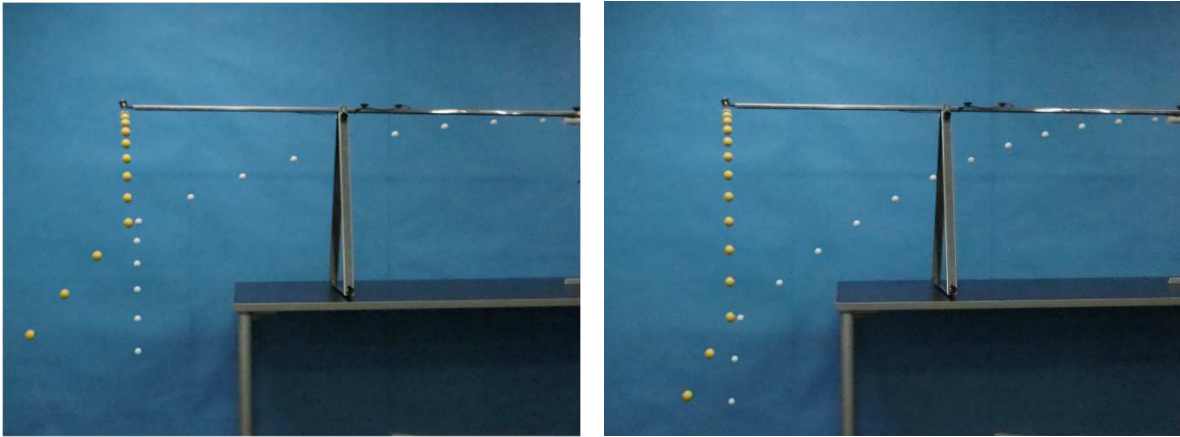
Examples of the demonstration:

Below photos were filmed in rapid shooting mode of a high-speed camera and processed using graphic software. Photos on the left are the stroboscopic images of the projectile launched with a greater magnitude, whereas those on the right are the images of the projectile launched with a smaller magnitude.

1. Example of Projectile Trajectory (when the launch angle is around 40 degrees above the horizontal plane):



2. Example of Projectile Trajectory (when launched horizontally):



Troubleshooting

Note this is a factory-adjusted product that should work successfully without any adjustment on site. Nevertheless, in case the projectile rarely hits the free-falling object, please carefully read the precautions again and go through the below adjustment procedure as needed.



Do not disassemble the product.

1. How to adjust the launching angle in horizontal direction:

1. Find Metallic Ring-shaped Plumb (MRP) connected with a magnet via a kite string in the product package.
2. Stick the magnet of MRP to the front of BRU to check the launching angle of the barrel in horizontal direction.
3. Launch a projectile from the ball launcher (without releasing the free-falling ball) and check if the projectile hits the string of MRP.
4. In case the projectile rarely hits the string, determine on which side of the string it travels.
5. Slightly (not fully) loosen the screw with a built-in knob further from the trigger/stopper button above the barrel. Turn both of the knurled screws along the side of the lower boom clockwise or counterclockwise.

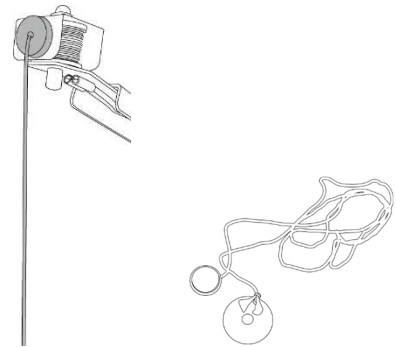


Fig. 10

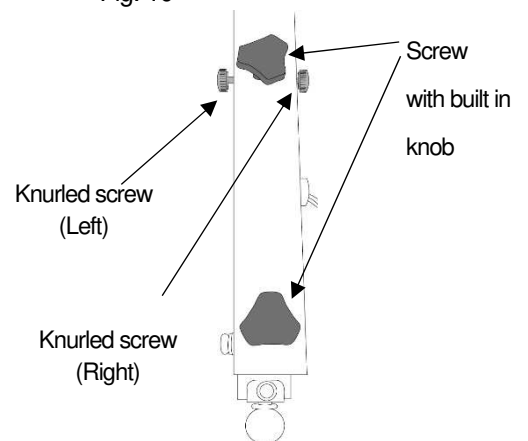


Fig. 11

For example, when adjusting the launching angle slightly to the left, [1] loosen (unlock) the screw knob further from the trigger/stopper button, [2]

loosen the knurled screw (left) counterclockwise, [3] tighten the knurled screw (right) clockwise as far as you can, and then [4] tighten the screw knob to lock the barrel again.

Launch the projectile again to check if the projectile hits the string. If not, repeat above procedure.

6. Only after making sure the projectile constantly hits the string, move to the next step to adjust the launching angle in the vertical direction.

2-1. How to adjust the launching angle in vertical direction:

1. Remove MRP from BRU.
2. Set the output voltages of the power supply to DC 3V.
3. Grasp the knob of SFP and slowly take SFP from the barrel. This automatically alters the built-in micro switch from the off state to on state, which starts the power supply to the coil of BRU. The iron core of BRU becomes magnetized.
4. Latch SFP at one of its four equally spaced shallow cuts (grooves) and stick the "Free-falling Object" to the iron core of BRU.
5. Lower the voltage of the power supplied to BRU and detect a threshold voltage value at which BRU can no longer suspend the plastic ball electromagnetically (the threshold should be somewhere between 1.2V and 2.5V).
6. Repeat above step 1 to 5 until determining the threshold out-put voltage. Once determining it, do not change the setting of the power supply.
7. Check if launched projectile hits the free-falling object. If not, observe whether the projectile trajectory travels over the free-falling object or beneath it.
8. If beneath, slightly lower the out-put voltage, so that BRU would bear less remanent magnetization* and the free-falling object would be released more synchronously.
9. Launch the projectile again. If the projectile rarely hits the free-falling object, nevertheless, move to the next step below.

* Remanent magnetization of BRU may defer the releasing timing of the free-falling object.

2-2. How to adjust the launching angle in vertical direction:

Consider the following procedure as the last resort for a successful demonstration. If this procedure does not work, do not adjust the product further and contact the distributor.

- a) To adjust the launching angle upward: Slowly rotate a screw with a built-in knob (1) counterclockwise little by little to increase the elevation angle of the barrel against the lower boom.

b) To adjust the launching angle downward: Slowly rotate a screw with a built-in knob (2) clockwise little by little to decrease the elevation angle of the barrel against the lower boom.

Check if the projectile successfully hits the free-falling object.

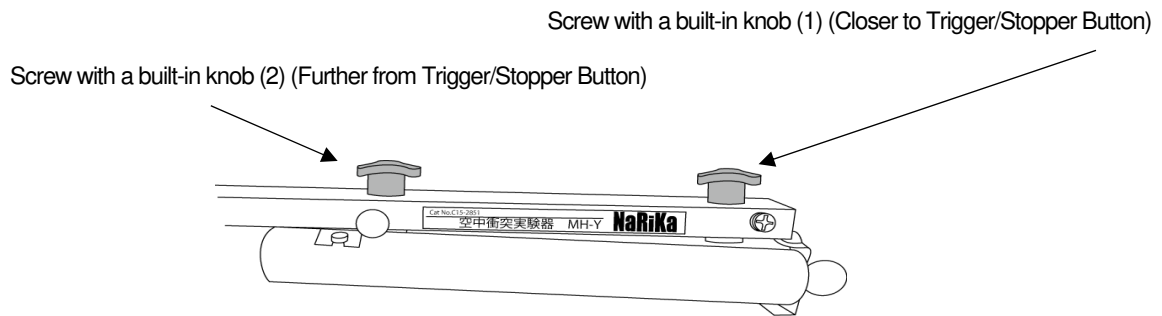


Fig. 12