

# COLLISION APPARATUS FOR KINETIC ENERGY with BEESPI V

N99-C15-2455



**Manual of Operations**

**IMPORTANT!**  
**Read the following before using this equipment:**  
Carefully follow all instructions and observe all precautions given in this manual

This apparatus includes a "Horizontal Ball Launcher" and BeeSpi V for measuring velocity of a launched ball. Kinetic energy changes depending on the velocity of the ball. It can be quantitatively obtained by measuring the distance a wooden block travels after a collision with a horizontal launched ball on a guide rail.

### Safety Precautions:

- Keep dry. Please do not expose to water. It may cause failure to the apparatus.
- Do not leave under direct sunlight or in high temperature places. This may cause problems and damage to the apparatus.
- Do not experiment on uneven or unlevel surfaces.

### Features:

- The initial velocity of the ball can be adjusted with the launcher unit. Using a speed measuring device, such as BeeSpi V together, the initial velocity of the ball can be measured.
- On the main body, next to the track, there are 3 indents to store the balls during experiments.
- The distance the wooden block travels after a collision is given by a scale on the track.

### Specifications:

**Main Body:** Approx. 1150 x 80 x 70 mm (including launcher unit)

**Launcher Unit:** Knob for setting manual or mechanical force adjustment for the initial velocity

**Balls:** Steel ball (diameter 25mm, 67g) x 1

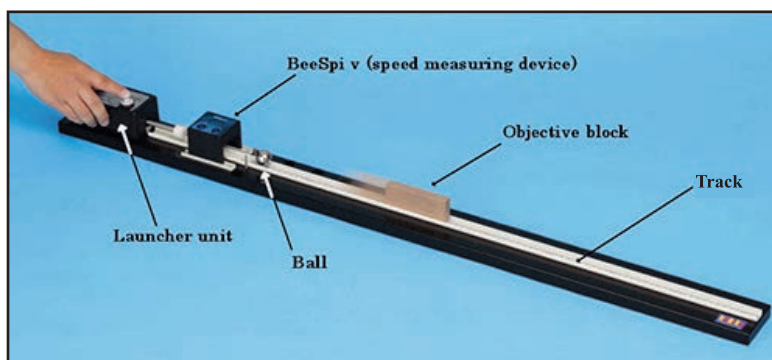
Ceramic ball (diameter 24mm, 19g) x 1

Plastic ball (diameter 25mm, 9.5g) x 1

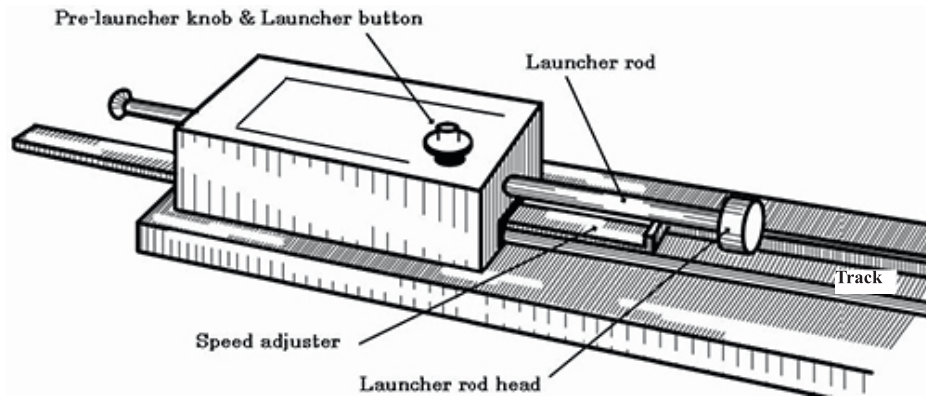
**Track:** Plastic track (length 1000mm) with a scale (length: 820mm, 1mm graduation)

**Wooden block:** Objective block (approx. 14 x 100 x 40 mm, approx. 28g) x 1

**BeeSpi V:** A speed measuring device (SKU: N99-S77-1321) x 1



## Instructions:



**Pre-launcher knob:** Knob for setting manual or mechanical force adjustment.

**Launcher button:** When using mechanical force adjustment, pressing the launcher button will launch the ball.

**Speed adjuster:** Launch speed can be controlled with the Speed adjuster. The adjuster has three settings as well as continuous settings between the steps.

**Launcher rod head:** The plastic block on the tip of the launcher rod called Launcher rod head. The head pushes the ball out.

**Launcher rod:** - For manual force adjustment, you pull back the launcher rod and release to launch the ball  
 - For mechanical force adjustment, you pull back the Launcher rod to set it and press the Launcher button to launch the ball

## Operation:

1. Position the Speed adjuster to any of the three settings to set the launcher power (see Fig.1).
2. Turn the knob into the upper position, into mechanical force adjustment (see Fig.1).
3. Position the Launcher rod to the Speed adjuster (see Fig.2).
4. Set ball in front of the launcher rod head (see Fig. 3).
5. Hold the launcher and press the Launcher button to launch the ball (see Fig.4).

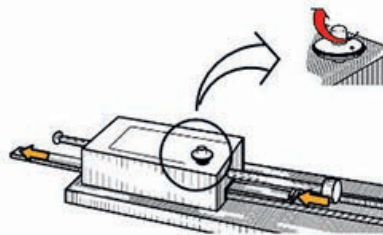


Fig.1

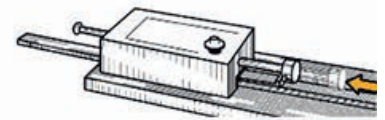


Fig.2

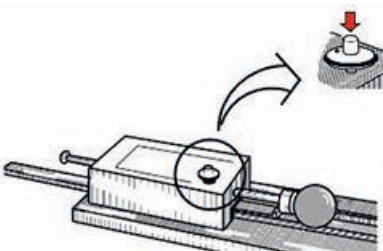


Fig.3

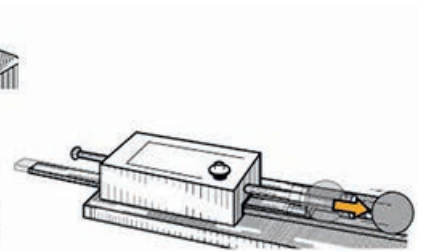


Fig.4

## Operation with BeeSpi V:

1. Set the BeeSpi V on the BeeSpi V holder (see Fig.5 and 6) after setting the launcher unit (see Operation).

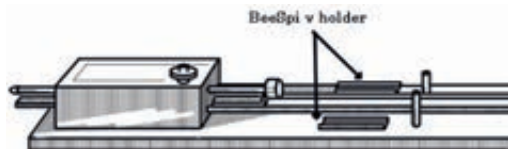


Fig.5

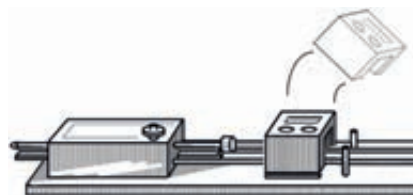


Fig.6

2. Place the ball in front of the launcher rod head (see Fig.7).
3. Place the wooden block correctly at the position of launch. The correct position is "0" on the scale taped on the track (see Fig.8).
4. Press the Start button on the BeeSpi V and select speed measurement.
5. Hold the launcher with your hand and press the Launch button to launch the ball.

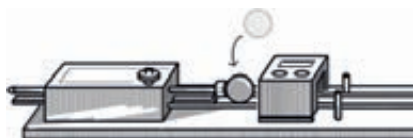


Fig.7

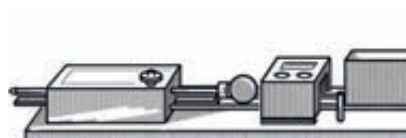


Fig.8

### [Important!]

- The launch position of the ball and position of the wooden block are extremely important for the experiment. If either the ball or wooden block are put in the wrong position, it may cause error in measurement.
- Hold the launcher unit when launching to get better data.

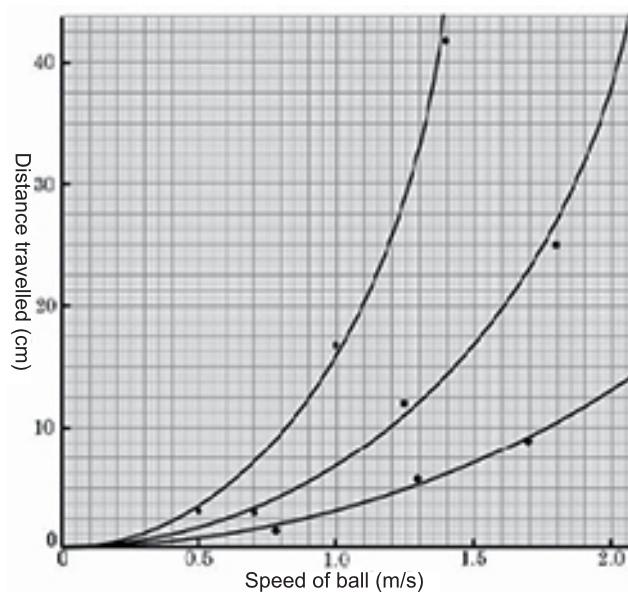
## Sample Experiment

# Confirmation of Kinetic Energy

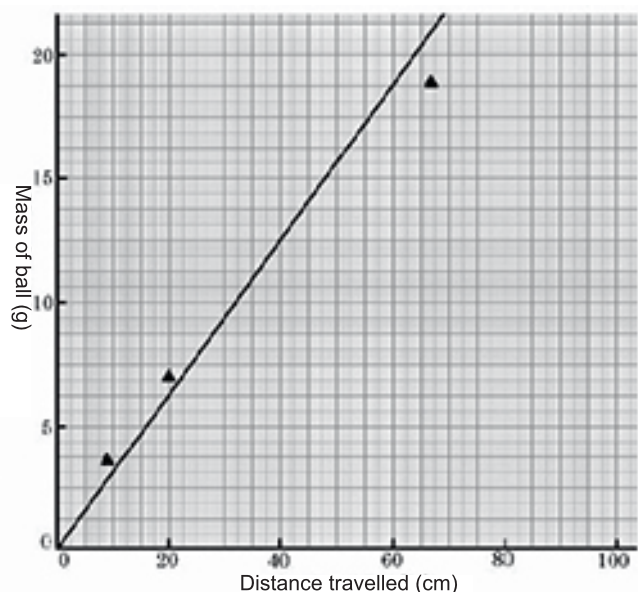
You may confirm that the kinetic energy (E) is proportional to the square of the velocity using this apparatus.

$$E = \frac{1}{2} m v^2$$

In a collision experiment with balls which are the same diameter and different weights (steel, ceramic, and plastic), and using a wooden block to collide with, you can record the distance it travels when collided with and the speed of ball (Graph 1). In the experiment, the distance the wooden block travels is proportional to the kinetic energy. The kinetic energy formula is confirmed by the graph (Quadratic curve). When speeds of the balls are controlled at 1.0 m/s by the Speed adjuster on the apparatus, the relation between the distance the wooden block travels and the mass of the ball can be recorded (Graph 2, Primary curve).



Graph 1



Graph 2

Data of Graph 1:

| Steel Ball: Mass = 67g                  |                     | Ceramic Ball: Mass = 20g                |                     | Plastic Ball: Mass = 95g                |                     |
|-----------------------------------------|---------------------|-----------------------------------------|---------------------|-----------------------------------------|---------------------|
| Distance travelled by Wooden block (cm) | Speed of ball (M/s) | Distance travelled by Wooden block (cm) | Speed of ball (M/s) | Distance travelled by Wooden block (cm) | Speed of ball (M/s) |
| 32                                      | 0.5                 | 2.91                                    | 0.697               | 1.62                                    | 0.782               |
| 194                                     | 1.0                 | 12.01                                   | 1.251               | 5.88                                    | 1.308               |
| 41.9                                    | 1.4                 | 24.3                                    | 1.758               | 8.86                                    | 1.657               |

Data of Graph 2:

| Steel Ball |                           |               |                     | Ceramic Ball              |               |                     |                           | Plastic Ball  |                     |  |  |
|------------|---------------------------|---------------|---------------------|---------------------------|---------------|---------------------|---------------------------|---------------|---------------------|--|--|
| Mass: 67g  | Moving distance of Wooden | Speed of Ball | Speed of ball (m/s) | Moving distance of Wooden | Speed of Ball | Speed of ball (m/s) | Moving distance of Wooden | Speed of Ball | Speed of ball (m/s) |  |  |
| 1          | 1                         | 0.191         | 0.191               | 1                         | 0.0           | 0.0                 | 1                         | 0.0           | 0.0                 |  |  |
| 2          | 2                         | 0.191         | 0.191               | 2                         | 0.0           | 0.0                 | 2                         | 0.0           | 0.0                 |  |  |
| 3          | 3                         | 0.191         | 0.191               | 3                         | 0.0           | 0.0                 | 3                         | 0.0           | 0.0                 |  |  |
| 4          | 4                         | 0.191         | 0.191               | 4                         | 0.0           | 0.0                 | 4                         | 0.0           | 0.0                 |  |  |
| 5          | 5                         | 0.191         | 0.191               | 5                         | 0.0           | 0.0                 | 5                         | 0.0           | 0.0                 |  |  |
| 6          | 6                         | 0.191         | 0.191               | 6                         | 0.0           | 0.0                 | 6                         | 0.0           | 0.0                 |  |  |
| 7          | 7                         | 0.191         | 0.191               | 7                         | 0.0           | 0.0                 | 7                         | 0.0           | 0.0                 |  |  |
| 8          | 8                         | 0.191         | 0.191               | 8                         | 0.0           | 0.0                 | 8                         | 0.0           | 0.0                 |  |  |
| 9          | 9                         | 0.191         | 0.191               | 9                         | 0.0           | 0.0                 | 9                         | 0.0           | 0.0                 |  |  |
| 10         | 10                        | 0.191         | 0.191               | 10                        | 0.0           | 0.0                 | 10                        | 0.0           | 0.0                 |  |  |
| Average    | 5.5                       | 0.191         | 0.191               | 5.5                       | 0.0           | 0.0                 | 5.5                       | 0.0           | 0.0                 |  |  |

Distance travelled by Wooden block (cm)      Speed of ball (m/s)

Table 1-1. Experiment result of the relationship between the distance travelled and the speed of the Steel ball.

| Steel Ball | Speed adjuster level 1 (Low Intensity) |               | Speed adjuster level 2 (Medium Intensity) |               | Speed adjuster level 3 (High Intensity) |               |
|------------|----------------------------------------|---------------|-------------------------------------------|---------------|-----------------------------------------|---------------|
| Mass: 67g  | Moving distance of Wooden              | Speed of Ball | Moving distance of Wooden                 | Speed of Ball | Moving distance of Wooden               | Speed of Ball |
| 1          | 1                                      | 0.37          | 18.7                                      | 0.98          | 42.2                                    | 1.44          |
| 2          | 2                                      | 0.37          | 18.7                                      | 0.98          | 42.2                                    | 1.44          |
| 3          | 3.4                                    | 0.52          | 18.7                                      | 0.98          | 42.2                                    | 1.44          |
| 4          | 3.1                                    | 0.52          | 18.7                                      | 0.98          | 42.2                                    | 1.44          |
| 5          | 3.1                                    | 0.52          | 18.0                                      | 0.95          | 42.4                                    | 1.42          |
| 6          | 3.5                                    | 0.50          | 20.0                                      | 0.97          | 44.8                                    | 1.45          |
| 7          | 3.3                                    | 0.52          | 19.1                                      | 0.96          | 43.1                                    | 1.41          |
| 8          | 3.1                                    | 0.50          | 20.3                                      | 0.99          | 40.4                                    | 1.41          |
| 9          | 2.9                                    | 0.49          | 19.1                                      | 0.91          | 39.0                                    | 1.37          |
| 10         | 3.3                                    | 0.51          | 21.1                                      | 0.99          | 38.4                                    | 1.43          |
| Average    | 3.2                                    | 0.51          | 19.4                                      | 0.97          | 41.9                                    | 1.42          |

Distance travelled by Wooden block (cm)      Speed of ball (m/s)

Table 1-2. Experiment result of the relationship between the distance travelled and the speed of the Ceramic ball.

| Ceramic Ball | Speed adjuster level 1 (Low Intensity) |               | Speed adjuster level 2 (Medium Intensity) |               | Speed adjuster level 3 (High Intensity) |               |
|--------------|----------------------------------------|---------------|-------------------------------------------|---------------|-----------------------------------------|---------------|
| Mass: 20g    | Moving distance of Wooden              | Speed of Ball | Moving distance of Wooden                 | Speed of Ball | Moving distance of Wooden               | Speed of Ball |
| 1            | 1                                      | 0.24          | 11.7                                      | 1.25          | 24.9                                    | 1.78          |
| 2            | 2                                      | 0.24          | 11.7                                      | 1.25          | 23.7                                    | 1.74          |
| 3            | 3.0                                    | 0.70          | 12.1                                      | 1.24          | 23.7                                    | 1.74          |
| 4            | 2.7                                    | 0.70          | 11.5                                      | 1.26          | 26.6                                    | 1.76          |
| 5            | 2.8                                    | 0.69          | 11.7                                      | 1.25          | 23.7                                    | 1.74          |
| 6            | 3.2                                    | 0.71          | 12.2                                      | 1.26          | 23.0                                    | 1.75          |
| 7            | 3.0                                    | 0.70          | 12.4                                      | 1.26          | 24.2                                    | 1.75          |
| 8            | 3.3                                    | 0.70          | 12.1                                      | 1.27          | 26.3                                    | 1.78          |
| 9            | 2.9                                    | 0.70          | 12.3                                      | 1.23          | 23.9                                    | 1.75          |
| 10           | 3.1                                    | 0.71          | 12.3                                      | 1.23          | 24.6                                    | 1.76          |
| Average      | 2.9                                    | 0.70          | 12.0                                      | 1.25          | 24.6                                    | 1.76          |

Distance travelled by Wooden block (cm)      Speed of ball (m/s)

Table 1-3. Experiment result of the relationship between the distance travelled and the speed of the Plastic ball.

| Plastic Ball | Speed adjuster level 1 (Low Intensity) |               | Speed adjuster level 2 (Medium Intensity) |               | Speed adjuster level 3 (High Intensity) |               |
|--------------|----------------------------------------|---------------|-------------------------------------------|---------------|-----------------------------------------|---------------|
| Mass: 9.5g   | Moving distance of Wooden              | Speed of Ball | Moving distance of Wooden                 | Speed of Ball | Moving distance of Wooden               | Speed of Ball |
| 1            | 1                                      | 0.31          | 5.9                                       | 1.29          | 10.2                                    | 1.66          |
| 2            | 1                                      | 0.31          | 5.9                                       | 1.33          | 9.0                                     | 1.61          |
| 3            | 1.5                                    | 0.77          | 6.0                                       | 1.31          | 9.0                                     | 1.63          |
| 4            | 1.6                                    | 0.78          | 6.3                                       | 1.31          | 9.3                                     | 1.65          |
| 5            | 1.7                                    | 0.79          | 5.0                                       | 1.27          | 10.4                                    | 1.69          |
| 6            | 1.7                                    | 0.79          | 5.7                                       | 1.31          | 7.8                                     | 1.77          |
| 7            | 1.6                                    | 0.78          | 6.0                                       | 1.31          | 8.2                                     | 1.58          |
| 8            | 1.7                                    | 0.79          | 6.0                                       | 1.33          | 7.9                                     | 1.59          |
| 9            | 1.8                                    | 0.80          | 6.0                                       | 1.33          | 7.9                                     | 1.59          |
| 10           | 1.7                                    | 0.80          | 6.0                                       | 1.33          | 7.9                                     | 1.59          |
| Average      | 1.6                                    | 0.78          | 5.9                                       | 1.31          | 8.9                                     | 1.66          |

Distance travelled by Wooden block (cm)      Speed of ball (m/s)