UNITED SCIENTIFIC SUPPLIES, INC.

OPERATING INSTRUCTIONS AND ACTIVITY GUIDE

BALLISTICS CAR

BLCAR1

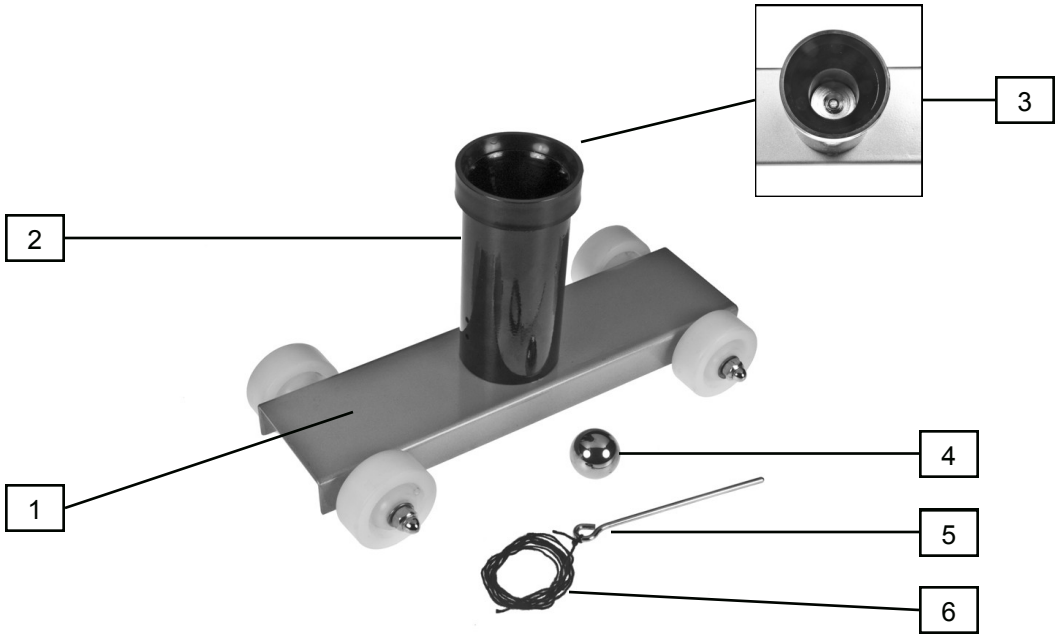

Figure 1

DESCRIPTION

The BLCAR1 Ballistics Car demonstrates the independence of horizontal and vertical motion. The apparatus consists of a four-wheeled cart (1, *Figure 1*) with a massive cylinder (2) mounted on its top surface. A spring-loaded piston (3) is located inside a vertical channel in the cylinder. A steel ball (4) fits into the channel. When the ball is loaded and pushed down against the spring, the piston is held in place with the spring compressed by a steel pin (5) that fits into holes in the side of the cylinder (not visible in *Figure 1*).

When the loaded car has been set in constant speed motion, a cord (6) attached to the steel pin is pulled to release the piston and eject the steel ball upwards. The motion of the ball is observed.

DIMENSIONS

Cart:	Length:	25 cm
	Width:	14 cm
	Height:	15 cm (including cylinder)
	Mass:	1.5 kg
Steel ball:	Diameter:	2.5 cm
	Mass:	67.1 g
Steel pin:	Length:	10 cm
	Diameter:	3.0 mm
Cord length:		1.2 m

THEORY

According to Newton's First Law of Motion, objects in motion do not change their speed or direction unless they are acted on by a force. If a force is present, then Newton's Second Law of Motion states that the change in the object's motion will be in the direction the force is acting.

Also, the rules for the resolution of vectors into components in different directions show that the size of the component of a force at right angles to its direction is zero.

Combining the above rules suggests that while the vertical force of gravity changes vertical motions, it should have no effect on a horizontal motion; the motions in the two dimensions should be independent of one another.

Figure 2 shows a steel ball that has just been ejected upwards from the moving Ballistics Car. The gravitational force will change its motion in the downwards direction, so its upwards motion will slow, then stop, then reverse, becoming accelerated downwards motion.

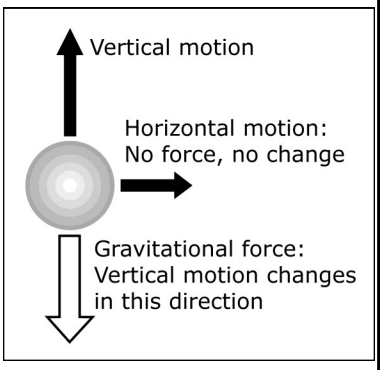

Figure 2

However, the ball experiences no corresponding horizontal force as it flies free (if we neglect the tiny force of air resistance), so its horizontal motion does not change. It continues at the same speed as the cart below it.

So when the ball falls back down again, the cart should still be below it, and it should land back in the channel it was ejected from.

The Ballistic Car demonstration allows this to be verified for two different ejection speeds.

OPERATION

- Choose a smooth, flat surface where the Ballistics Car can run in a straight line for about 2m.
- Insert the steel ball into the channel on the top of the cylinder (*Figure 3*).

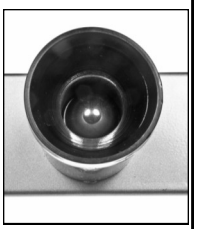

Figure 3