XV...The Inverse-Cube Law of Magnetic Forces

Introduction:.

A simple experiment with your instrument can be used to show that magnetism follows an inverse-cube law rather than the familiar inverse-square law that radiation and gravity follow.

Procedure:

The magnet on the card will sense the iron mass as it is moved closer and closer to the soda bottle. This will cause a deflection of the light spot on the wall. Measure the location of the light spot and plot its deflection from the null position against the distance between the magnet and the iron mass.

Materials:

1) The Magnetometer
2) A 6-10 pound container of iron nails or the equivalent

Sample Data:

The magnetometer in this high-sensitivity mode was 5 meters from the wall. From the resolution formula, this corresponds to an angular deflection scaling of 0.28/5 = 0.056 degrees per centimeter. The null position was at 225 centimeters. The weight of the iron was 6.2 pounds.

Spot Position	Mass Location	Angular Deflection
225 cm	24 inches	0.00 degrees
230 cm	12 inches	0.28 degrees
240 cm	10 inches	0.84 degrees
260 cm	7 inches	1.96 degrees
290 cm	5 inches	3.64 degrees

Calculation of deflection for the first measurement:

Angle = 0.056 X (230 - 225)

= 0.056 X 5 cm

= **0.28 degrees**

You can use a calculator to verify that the force law is not inverse square, but is closer to inverse-cube to within the measurement accuracy as follows:

The distance is changed from 5 inches to 12 inches, which is a factor of (15/5) = 2.4
The deflection change between these two locations is a factor of (3.64/0.28) = 13.0.

If the force law was Inverse-square, the deflection change would have been a factor of $(2.4)^2$ = 2.4 x 2.4 = 5.76.

If the force law is Inverse-cube, then the deflection change would be closer to a factor of $(2.4)^3$ = 2.4 x 2.4 x 2.4 = 13.8 which is very close to what was actually measured.

Students may combine their measurements by averaging them and reduce the measurement error.