Projectile Motion and Conservation of energy
PHYS 1493

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1 Introduction

In this experiment, we test our ability to predict the motion of a small projectile using simple equations. We will carry out a series of trials and perform statistical analysis. We will then compare our data to expected values derived using equations (1), (2), and (3).

Work by Friction

$$W_f = mg(h'_1 - h'_2) \tag{1}$$

Initial Velocity

$$v_0 = \sqrt{\frac{10}{7m}(mg(h_1 - h_2) - W_f)} \tag{2}$$

Projectile Motion

$$V_x(t) = V_0 cos(\theta), \quad V_y(t) = V_0 sin(\theta) - gt \tag{3}$$

2 Method

a. Estimate the work done by friction

   (a) Adjust the ramp angle adjustment screw such that when the sphere is released at the release point, the sphere makes it just to the edge of the ramp before reversing direction.

   (b) Record measurements h'_1, and h'_1.

   (c) Use equation (1) to derive work done by friction W_f. Note that the mass of the sphere is not necessary. Calculating $\frac{W_f}{m}$ will suffice since m will be canceled out in equation (2).

b. Conduct Trials

   (a) Adjust the ramp angle adjustment screw such that:

$$h_1 - h_2 > 2(h'_1 - h'_2) \tag{4}$$

   (b) Use the new measurements of the ramp h_1, h_2, h_3, D, L and the equations (1), (2), and (3), to predict where the sphere will land.

   (c) Release the sphere from the release point and confirm if the prediction is accurate.

   (d) Place a sheet of white paper on the floor where the sphere is predicted to land.

   (e) Place a sheet of carbon paper on top of the white paper

   (f) Draw crosshairs on the sheet through the point where the sphere is predicted to land.

   (g) Release the sphere 20 times and record the results.

c. Repeat the procedure for a different set of measurements, h_1, h_2, h_3, D, L and a different sphere.

3 Data

Table 1: Metal, Trial 1

x(mm)	z(mm)
1.90	-0.10
2.45	-0.15
2.55	-0.35
2.75	-0.35
2.80	-0.45
2.55	-0.05
2.70	0.00
2.95	-0.20
3.20	-0.30
2.30	0.30
2.40	0.25
2.45	0.10
2.60	0.20
2.65	0.20
2.70	0.30
2.85	0.05
3.00	0.40
2.60	0.05
2.65	0.05
2.70	0.10

Table 3: Metal, Trial 2

x(mm)	z(mm)
1.65	3.25
2.00	3.10
1.80	3.05
1.90	2.85
2.15	2.85
2.40	2.80
1.85	2.65
2.05	2.65
2.90	2.70
1.80	2.60
1.70	2.40
1.95	2.55
2.10	2.50
2.00	2.35
2.00	2.80
2.10	2.80
1.90	2.60
2.05	2.60
2.20	2.60
2.10	2.50

Table 2: Plastic, Trial 1

x(mm)	z(mm)
3.15	1.45
2.70	1.80
2.65	1.90
2.55	1.95
2.40	0.20
3.15	2.00
3.75	2.15
2.60	2.25
1.80	2.20
1.40	2.35
2.35	2.45
2.40	2.45
2.70	2.50
2.95	2.70
3.25	2.65
2.45	2.95
2.60	2.90
2.75	2.75
2.80	3.00
2.90	3.00

Table 4: Plastic, Trial 2

x(mm)	z(mm)
-1.65	-2.85
-2.35	-2.80
-3.00	-2.85
-1.90	-2.40
-0.70	-2.30
-1.40	-2.25
-2.40	-2.15
-1.65	-2.45
-1.60	-2.10
-1.30	-1.70
-1.40	-1.50
-1.55	-1.45
-1.85	-1.25
-1.80	-1.45
-2.80	-2.00
-2.45	-2.10
-2.65	-1.85
-2.60	-1.65
-2.35	-1.45
-2.20	-1.70

4 Data Analysis

The atomic weight of magnesium is concluded to be $24\,\mathrm{g\,mol^{-1}}$, as determined by the stoichiometry of its chemical combination with oxygen. This result is in agreement with the accepted value.

5 Conclusions

The accepted value (periodic table) is $24.3\,\mathrm{g\,mol^{-1}}$ **?**. The percentage discrepancy between the accepted value and the result obtained here is 1.3%. Because only a single measurement was made, it is not possible to calculate an estimated standard deviation.

The most obvious source of experimental uncertainty is the limited precision of the balance. Other potential sources of experimental uncertainty are: the reaction might not be complete; if not enough time was allowed for total oxidation, less than complete oxidation of the magnesium might have, in part, reacted with nitrogen in the air (incorrect reaction); the magnesium oxide might have absorbed water from the air, and thus weigh "too much." Because the result obtained is close to the accepted value it is possible that some of these experimental uncertainties have fortuitously cancelled one another.