Coulomb's Law Lab
PHY-222-AC01

Jasper Runco

August 24, 2020

1 Theory

Coulomb's law describes a mathematical expression for the interaction of electrically charged objects. The electrical charge generates a force pair, F_E, with a magnitude that has been experimentally determined to such a degree that it is accepted as a universal law.

1.1 Definitions

Electrically charged object - Matter with more or less electrons than protons is negatively or positively charged respectively.

Force pair - The principal of Newton's third law in which every action force has a corresponding reaction force equal in magnitude and opposite in direction.

Coulomb's law -

$$F_E = k\frac{q_1 q_2}{r^2}$$

r - The distance between the charged objects measured in meters.

$q_1 q_2$ **-** The sum of the electrical charges of each object, measured in Coulombs.

k - The coulomb constant, the experimentally determined proportionality constant with a value of $k = 9.0 \times 10^9 \frac{Nm^2}{C^2}$

2 Objectives

First Objective
Experimentally confirm Coulomb's law.

Second Objective
Study how distance and charge affect the electric force.

Third Objective

Experimentally determine the value of the electric constant, k.

3 Experimental Data

3.1 Part One

Table 1:

$q_1 = 2\mu C$		$q_2 = 4\mu C$	
r(cm)	$r^2(m^2)$	$\frac{1}{r^2}(\frac{1}{m^2})$	$F_E(N)$
10	1.0×10^{-2}	1×10^2	7.190
9	8.1×10^{-3}	1.2×10^2	8.877
8	6.4×10^{-3}	1.6×10^2	11.234
7	4.9×10^{-3}	2.0×10^2	14.674
6	3.6×10^{-3}	2.8×10^2	19.972
5	2.5×10^{-3}	4.0×10^2	28.760
4	1.6×10^{-3}	6.3×10^2	44.938
3	9.0×10^{-4}	1.1×10^3	79.889

3.2 Part Two

Table 2:

$q_1 = 5\mu C$	$r = 6cm$
$q_2(\mu C)$	$F_E(N)$
10	124.827
9	112.344
8	99.862
7	87.379
6	74.896
5	62.414
4	49.931
3	37.448

4 Data Analysis

5 Results and Conclusions

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.

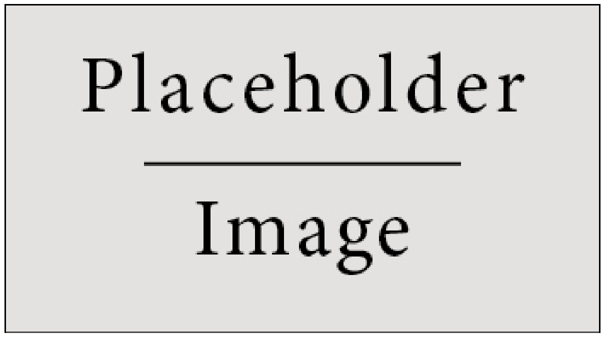

Figure 1: Figure caption.

6 Discussion of Experimental Uncertainty

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.

7 Answers to Definitions

a. The *atomic weight of an element* is the relative weight of one of its atoms compared to C-12 with a weight of 12.0000000…, hydrogen with a weight of 1.008, to oxygen with a weight of 16.00. Atomic weight is also the average weight of all the atoms of that element as they occur in nature.

b. The *units of atomic weight* are two-fold, with an identical numerical value. They are g/mole of atoms (or just g/mol) or amu/atom.

c. *Percentage discrepancy* between an accepted (literature) value and an experimental value is

$$\frac{\text{experimental result} - \text{accepted result}}{\text{accepted result}}$$