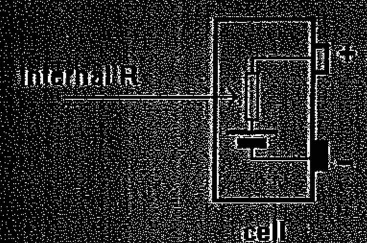
2013

Internal Resistance Lab



AP PHYSICS

12/20/12

Abstract

In this experiment we wanted to find the internal resistance of a nine volt battery. We did this by creating a simple circuit with an amp-meter a voltmeter and an alterable resistor and then changing the resistance to alter the current of the circuit which allows us to see a change in the internal resistance. Using the experiment we were able to use three different batteries and then compare the batteries to see which one is the best.

Purpose

This experiment was being performed in order to find the internal resistance of a battery. Then using this experiment we could compare the batteries to which one has a lower internal resistance and therefore is better. We predicted that the Duracell battery would have the lowest internal resistance because it is historically know to be a better battery. This experiment was done by finding the relationship between the voltage and the current for different resistances in a circuit using each of the batteries then plotting the points and the least squares regression line is our internal resistance of each battery. This experiment is useful because then we can use it to experiment on different ways to make batteries better by making the internal resistance lower and lower. At the end of the experiment we had a better understanding of circuits and the internal resistance of batteries.

Theory

Internal resistance is the inherent resistance in a battery caused by specific battery's size, chemical properties, age, and usage. The larger the battery, the older the battery, and the more used the battery the more internal resistance it will have. The effect of the chemical properties is not predictable by current scientific knowledge. When graphed, the Voltage and the Current, the slope of the line should be approximately the value of the internal resistance of the battery.
To calculate internal resistance this formula is used.

$V = I*RTotal$

$V = I(R+r)$

Rearranged:

$r = V/I - R$

r = Internal Resistance

RTotal = Total Resistance

R = Total Resistance - Internal Resistance

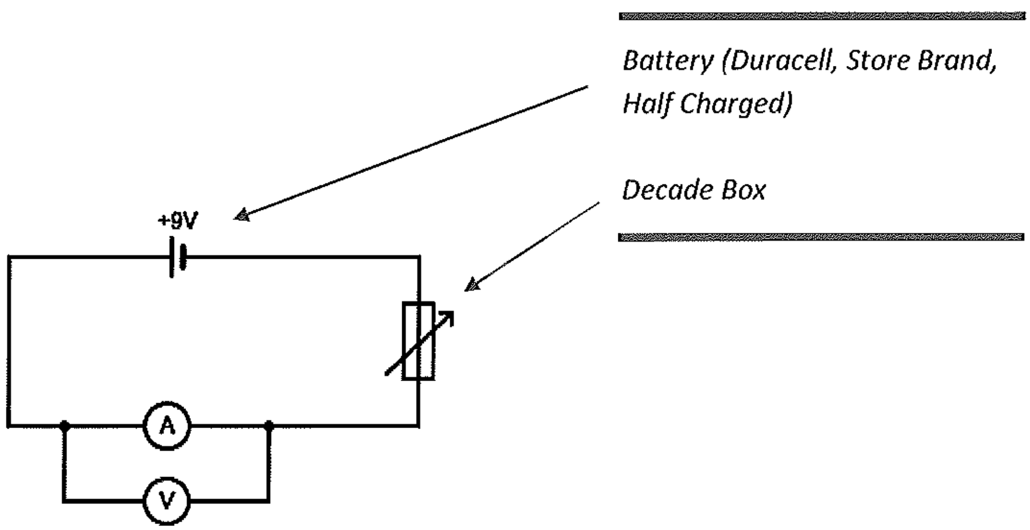
V = Voltage

I = Current

Apparatus and Procedure

To calculate the internal resistance of the batteries, a simple circuit was made using a voltmeter, an ammeter and a decade box and the batteries provided. Using the decade box, the resistance of the circuit was altered, which allowed for measuring the changes in current, and voltage passing through the meters. Once this was found, the data was plotted and the slope of Amps vs Voltage was found to find the internal resistance of the batteries.

Circuit Diagram



Apparatus Used

1. Lab Wire
2. Decade Box
3. Analog Voltmeter
4. Analog Ammeter
5. Duracell Battery (New)
6. Store Brand Battery (New)
7. Energizer Battery (Half Used)

Results

Battery Type	Volts	Current (A)
Energizer	7.1	0.175
	7.2	0.145
	7.3	0.12
	7.4	0.105
	7.5	0.075
	7.7	0.038
	7.7	0.025
	7.8	0.019

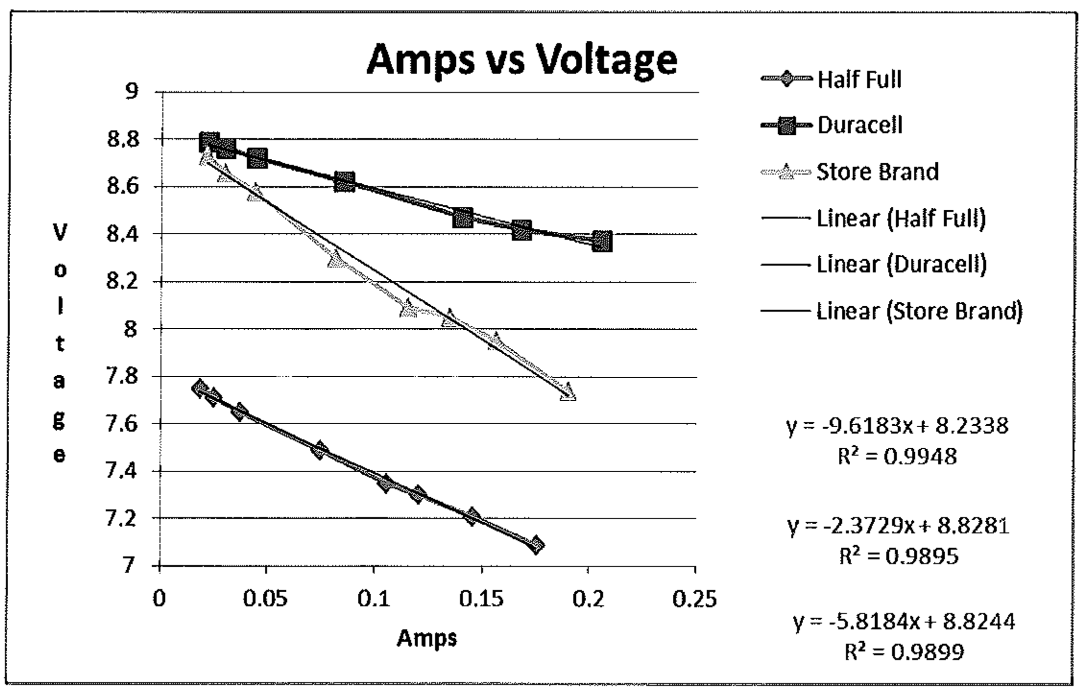
Battery Type	Volts	Current (A)
Duracell	8.4	0.205
	8.4	0.167
	8.5	0.14
	8.6	0.085
	8.7	0.045
	8.8	0.03
	8.8	0.022

Battery Type	Volts	Current (A)
Store Brand	7.7	0.19
	8	0.156
	8.1	0.134
	8.1	0.115
	8.3	0.082
	8.6	0.044
	8.7	0.03
	8.7	0.022

Energizer Internal Resistance= 9.62 Ohms

Duracell Internal Resistance = 2.37 Ohms

Store Brand Internal Resistance = 5.81 Ohms



Discussion

The terminal voltage of a battery differs from its reported EMF due to the internal resistance. To maximize battery efficiency, one must minimize the internal resistance. The group analyzed the voltage, current, and finally the internal resistance of a Duracell, store brand CVS, and half-filled battery. Plotting the recorded voltage vs. the amperage and using the equation Terminal Voltage = EMF – Ir where I is the current flowing through the battery and r is the internal resistance, we determined the internal resistance of each battery using the slopes of the lines of best fit. The Duracell battery had the lowest internal resistance at 2.3729 ohms. Next were the store brand battery with 5.8184 ohms and finally the half-filled battery with 9.6183 ohms. An ideal battery has very little internal resistance, giving it the maximum amount of voltage. The Duracell battery appears to be the best based on our results, which is not surprising when compared to the generally lower-quality CVS batteries. The half-filled battery having the highest internal resistance is also not surprising. This could possibly be explained by how since there are less chemicals within the half-filled battery, there are naturally less electrochemical reactions which generate voltage. Possible sources of error in our experiment include misreading of the ammeter and voltmeter, and similarly, approximations of readings. Defunct ammeters and voltmeters could also contribute to error.

Conclusion

The purpose of the experiment was to determine the internal resistance of three batteries based on voltage vs. amperage graphs. The results indicate reasonable amounts for the terminal voltages of the three batteries, and follow our hypothesis in that the Duracell battery would have the least internal resistance while the half-filled would have the most. Utilizing the equation Terminal Voltage=EMF-Ir, one can generally find the internal resistance with a known EMF and a varied voltage/current. The method used in the experiment can be generalized in order to better evaluate battery efficiency, and to understand the effectiveness of battery in everyday or advanced settings.