A Visual Model of Battery Discharge

This demonstration only serves as an approximation of how a battery discharges over time.

Name_____ **Date**_____

Materials

¼" drill bit
1" drill bit
5 Gallon Bucket
1 x 1 ¼" #6 Rubber Stopper
¼" lag bolt
¼" steel washer
¼" rubber washer
Stop Watch

Charged batteries can be imagined as being like a 5 gallon bucket of water. If a ¼" diameter hole were drilled into the bottom of the bucket, the water would leak out over time, at a rate that could be repeated with accuracy. In fact ancient water clocks were constructed in this manner. The water draining from the bucket is analogous to the current supplied by the battery.

If the same bucket had a hole drilled into it of 1 inch in diameter, the water would drain faster. Makes sense, right?

This is an experiment worth trying. It is interesting to try and predict how much faster the water will run out of the 1" hole.

What do you think?

This activity is offered in the expectation that participants will obtain a "Visual" model of current drain and voltage drop by watching the water stream pressure drop (voltage) as the bucket (battery) empties. The concept of a finite expendable amount of energy being "Drained" from the battery is also helpful.

Please note however that:

Drain rates are not directly proportional to the hole diameters.
Note that a 4x increase in hole DIAMETER ¼" – 1") results in an approximately, 15X increase in drain rate. This is suggestive of what happens to battery capacity as we increase the current draw.

Drain rate is directly proportional to the cross sectional area of the hole! A 1" diameter hole has about 15x the cross sectional area of a ¼" diameter hole. A bucket of water will drain 15x faster through a 1" hole than through a ¼" hole. Battery drain over time is NOT directly proportional to the discharge rate in amperes. It is beneficial for students to learn that this Battery/Bucket model can only serve as a visual example of current drain if the rate of

Spend some time to work the math of comparing drain rates with respect to hole diameter increases as well as with respect to cross sectional area increases. There is certainly much to learn about circles in this exercise.

Directions
Note: This activity is best performed outside.

1.) Obtain a clean empty 5 gallon bucket. These are often available from restaurants and delicatessens.
2.) On the side of the bucket drill a ¼" hole with a center 1" up from the bottom of the bucket.
3.) Diametrically opposite the ¼" hole drill a 1" hole with a center 1" up from the bottom of the bucket.
4.) Plug the 1" hole with a rubber stopper available from the High School Chem lab or local hardware store. Plug the ¼" hole with a ¼" lag screw and rubber washer.
5.) Mark a level 3" above the top of the 1" hole with a permanent marker.Fill the bucket to this level.
6.) Add 3 Gallons of water and mark this water line. This will provide you with a reasonably consistent volume and pressure from which to base your observations.
7.) Open the ¼" hole and record the time required to drain the bucket.
8.) Repeat using the 1" hole.
9.) Compare and discuss the results.

Circular Area $= \pi * r^2$

	#1 Hole Diameter	**#2 Hole Diameter**	**#1 Hole Area**	**#2 Hole Area**
Drain Time in Seconds				
Drain Rate in Gallons/sec.				

Conclusions:

Batteries are "Buckets of Energy" and the energy they contain is highly disproportional to their weight. Understanding battery characteristics will help you optimize your battery selection leaving more available weight for transport and weapon systems.