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Week 4 Studio 1

Group 4b

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**Activity #1: An experiment to understand the impact of internal resistances in batteries, as well as to estimate their values in the two given ‘D’ size batteries**

3.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | Duracell | | | Energizer | | |
| Nominal resistance value(Ω) | Measured resistance value R(Ω) | Voltage VR(V) | | Current IR(A) | Voltage VR(V) | | Current IR(A) |
| ∞(open circuit) |  | 1.579 | |  | 1.599 | |  |
| 4.7Ω | 4.84 | 1.491 | | 0.308 | 1.496 | | 0.309 |
| 5.6Ω | 5.75 | 1.503 | | 0.261 | 1.510 | | 0.263 |
| 8.2Ω | 8.25 | 1.524 | | 0.185 | 1.538 | | 0.186 |
| 10Ω | 9.95 | 1.536 | | 0.154 | 1.546 | | 0.155 |

6. VR = Vopen - IRRint

7. Plotting a graph of VR against IR, the graph will be a straight line with gradient of -Rint and y-intercept of Vopen.

From the graph, Rint = -gradient = 0.2877Ω and Vopen = y-intercept = 1.5789V

From the graph, Rint = -gradient = 0.3338Ω and Vopen = y-intercept = 1.5987V

8. The battery’s terminal voltage will decrease as the current drawn from the battery increases.

9. A good battery should have low internal resistance as the power loss to the internal resistance will be lower, Ploss = I2R.

10. When the terminals of the Duracell is shorted, the theoretical current = 1.579/0.2877 = 5.49A. The instantaneous power loss = 5.492 \* 0.2877 =8.67W

**Activity #2: An experiment to estimate the internal resistance of a power source formed by connecting two cells in parallel**

2.

|  |  |  |  |
| --- | --- | --- | --- |
|  | | Parallel Batteries | |
| Nominal resistance value(Ω) | Measured resistance value R(Ω) | Voltage VR(V) | Current IR(A) |
| ∞(open circuit) |  | 1.590 |  |
| 4.7Ω | 4.84 | 1.540 | 0.318 |
| 5.6Ω | 5.75 | 1.548 | 0.269 |
| 8.2Ω | 8.25 | 1.561 | 0.189 |
| 10Ω | 9.95 | 1.565 | 0.157 |

4. VR = Vopen - IRRint

Plotting a graph of VR against IR, the graph will be a straight line with gradient of -Rint and y-intercept of Vopen.

From the graph, Rint = -gradient = 0.1571Ω and Vopen = y-intercept = 1.5902V

6. Imeasured = -2.5mA

There are internal resistance in the two parallel batteries respectively so it is a closed circuit and the voltage of the two batteries are different.

7. VD – VRD – VRE – VE =0

VRD = Itheoretical\*RD ; VRE = Itheoretical\*RE

Itheoretical = (VD – VE)/(RE +RD) = (1.579 – 1.599)/(0.2877 +0.3338) = -32.2mA

Percentage difference between Imeasured and Itheoretical = (-32.2 - -2.5)/-2.5 \* 100% = 92.2%

The values of Imeasured and Itheoretical are very different as the battery discharges very fast.

8. Vtheoretical for open circuit= VD - Itheoretical\*RD = 1.579 – (-32.2\*10-3)\*0.2877 = 1.588V

Percentage difference between Vopen in Step 1 and Vtheoretical = (1.590 – 1.588)/1.590 \* 100% = 0.13%

Rtheoretical for internal resistance= (RD\*RE)/(RD + RE) = (0.2877\*0.3338)/(0.2877+0.3338) = 0.1545Ω

Percentage difference between Rint and Rtheoretical = (0.1571 – 0.1545)/0.1571 \* 100% = 1.65%

The percentage difference for both cases are very small.

9. The internal resistance of the combined parallel batteries is smaller than the internal resistance of each of the two individual batteries. The advantage of having a smaller internal resistance is that the power loss of the internal resistance will be smaller, Ploss = I2R.

10. The voltage of the cells chosen should be similar. Otherwise there will be internal current flowing through which will increase the power loss.