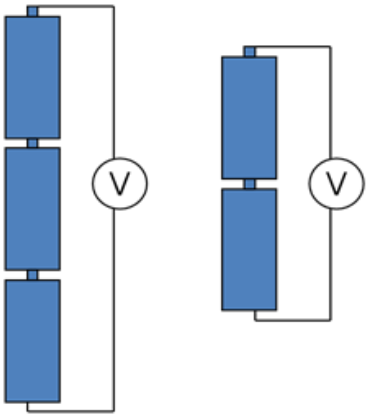
Section 5: Cells and Batteries

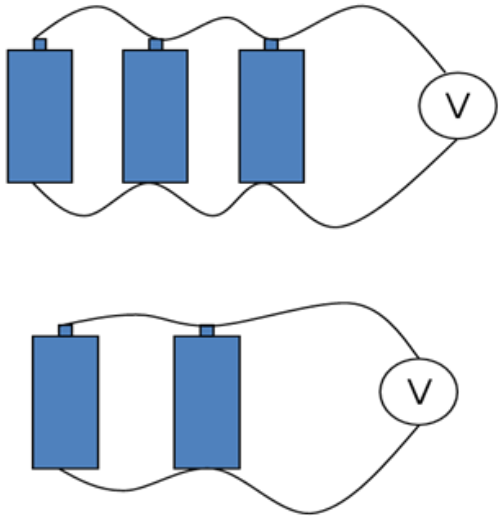
A combination of cells is called a **battery**. Cells are commonly combined so that they can generate a larger potential difference - the greater the number of cells, the stronger the battery and the more expensive the battery.

Cells in Series

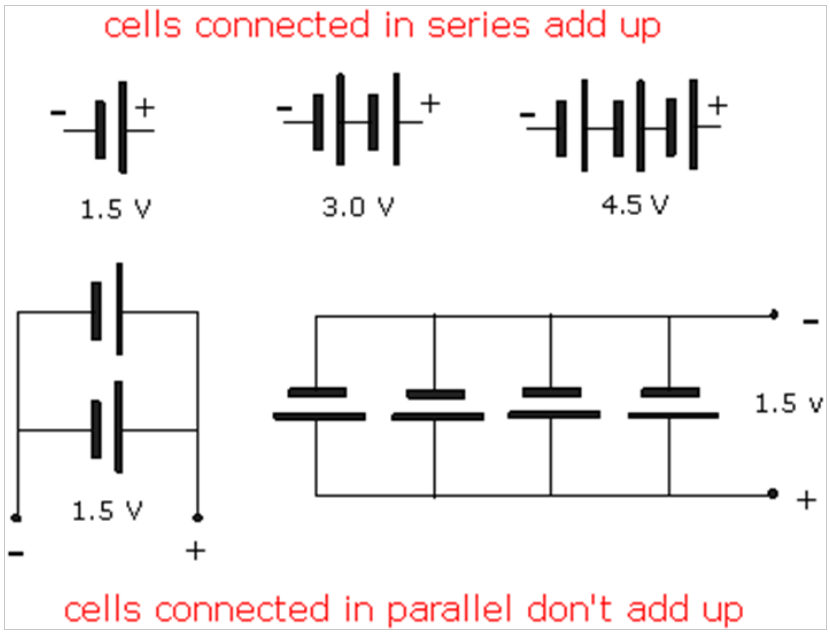


$V_T = V_1 + V_2 + \ldots$

Cells in Parallel



$V_T = V_1 = V_2 = \ldots$



Question: If cells in parallel maintain the same voltage as a single cell, what's the point in using such arrangements?

Answer: Cells connected in parallel last longer. Each cell in parallel is providing only a portion of the required current. For example, if a current of one ampere is being drawn from four cells in parallel, then each cell provides only 1/4 of an ampere. This means the 4 cells will last 4 times longer than one cell.

The advantage of connecting cells in series is obvious: the resulting battery has a higher voltage than a single cell. (The larger the voltage, the larger the current that can be provided - - more on this later – Ohm's Law)

Examples:

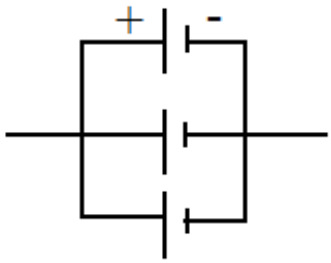
1. Find the voltage of each combination if the voltage of each cell is 1.5 V.

A)

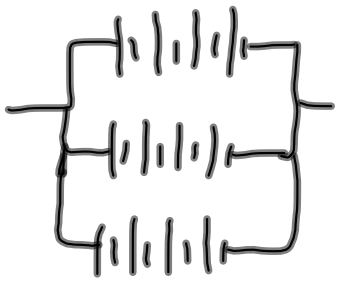
$V_T = 3 \times 1.5\,V$

$= 4.5\,V$

B)



$V_T = 1.5V$

C) 

D)

$V_T = 4 \times 1.5\,V$
$= 6\,V$

2. The battery required by a CD player can provide 10 C of charge when the chemical action in the battery expends 90 J of energy. How many dry cells would it take to operate the CD player?

$Q = 10\,C$
$E = 90\,J$
$N = ?$

$V = \frac{E}{Q} = \frac{90\,J}{10\,C} = 9\,V$

$9\,V \div 1.5\,V = 6$ cells in series

3. How many electrons move through a circuit when 3.0×10^2 J of energy are expended by <u>two 1.5 V</u> cells connected in series?

$V = 3\,V$
$E = 300\,J$
$N = ?$
$Q = ?$

$V = \frac{E}{Q}$

$Q = \frac{E}{V} = \frac{300\,J}{3.0\,V} = 100\,C$

$Q = Ne$

$N = \frac{Q}{e} = \frac{100\,C}{1.602 \times 10^{-19}\,C} = 6.2 \times 10^{20}$

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